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CONTENTS

Editor's Outlook:	Page
Albert Abraham Michelson	2109
The Philosophy of Grading	2111
The Borax Industry in Southern California. W. F. Dingley	2112
The Amphoteric Elements and Their Derivatives: Some of Their Physical and Chemical Properties. Charles A. Kraus	2126
Caricatures of Chemists as Contributions to the History of Chemistry. Lyman C. Newell	2138
The Physics and Chemistry of Surfaces. Eric K. Rideal	2156
The Chemical Expert. Wm. M. Grosvenor	2159
The Purpose and Plan of the Institute of American Meat Packers. C. Robert Moulton	2165
Analysis of Materials of the Middle Bronze Age. Wm. B. Meldrum and Arthur E. Palmer	2171
The Chemistry of Some Suggested Insulin Substitutes. Charles E. Braun	2175
An Experiment in Teaching Chemical Engineering. Edwin Strommen	2188
An Experiment in Second-Year College Chemistry. A. H. Kunz	2192
The Second Law and Entropy. R. C. Cantelo	2198
Zero Cold Test. Harold J. Tormey and Joseph B. Ennis, Jr.	2202
Drawing Reproduction and Lantern Slide Making. H. C. Benedict and R. Lee	2208
Lantern Slides from Cellophane. John L. Wilson	2212
A New Type of Chemistry. Robert Collier, Jr.	2214
The New-Type (Objective) Examinations in High-School Chemistry. K. M. Persing	2227
Is a High-School Chemistry Club Worth While? Otto J. Walrath	2238
A Different Open-House Program. Dorothy Engle and Jean McBrien	2241
Some Remarks on the Determination of Formulas. Kenneth D. Dodds	2244
A Table of Solubilities and Colors of Precipitates for Use in a Course in Qualitative Analysis. Wayne E. White	2247
Reaction Charts. R. H. Crist	2251
Motor Stirring Apparatus. G. Ross Robertson	2254
Laboratory Apparatus for Illustrating Graham's Effusion Law. Paul Emil Wenaas	2257
Doctorates in Chemistry and Related Fields Conferred by American Universities, 1930–31. Clarence J. West and Callie Hull	2259

A Distilling Flask Which Prevents Refluxing in the Vacuum Distillation of High-Boiling Liquids. PAUL E. BURCHFIELD..... 2279

Correspondence:

Fragments of Early Industries in South Jersey. K. BRADDOCK-ROGERS.... 2280
Correction: Alexander Borodin—Chemist and Musician. F. H. GETMAN... 2282

Abstracts:

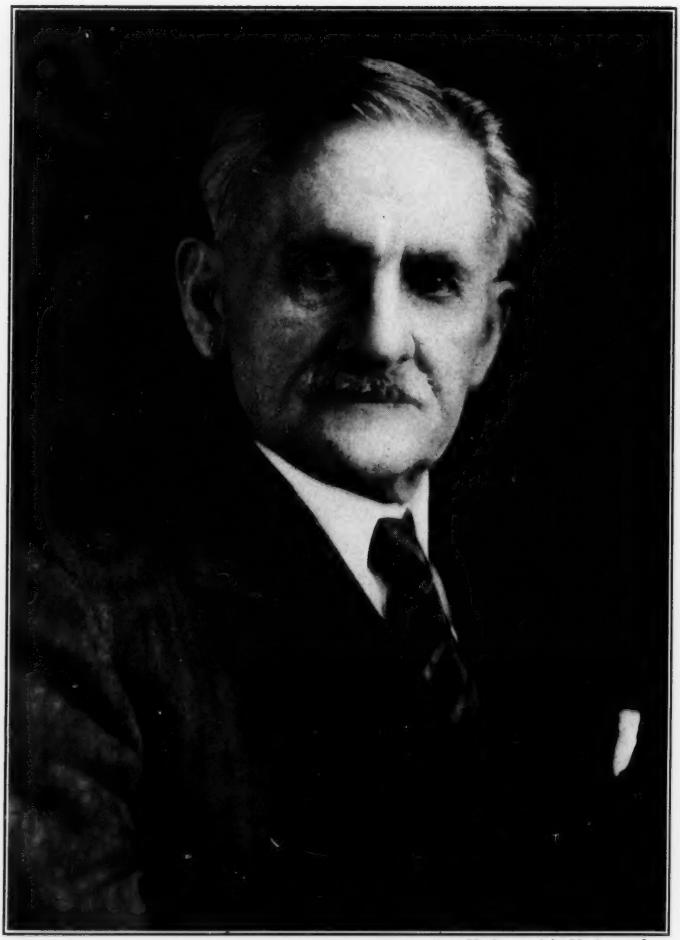
Teaching Objectives, Methods, and Suggestions..... 2283
Administrative Problems and Devices; Curricula..... 2283
Keeping Up with Chemistry..... 2284
Scientific Reviews and Bibliographies..... 2285
Historical and Biographical..... 2285
The Philosophy of Education..... 2285
Contemporary News and Comments in Science and Education..... 2285

Contemporary News in Chemistry and Education:

The Louise C. Buhl Hall of Science of the Pennsylvania College for Women. DOROTHY EDSALL..... 2287
Research Reports from the Meeting of the A. C. S., Buffalo, August 31–September 4, 1931; Electrons Speed within Dense Solids; Synthetic Antiseptic Is New Hookworm and Ascaris Remedy; Common Water Purifier Prevents "Athletic Foot"; Research on Paperboard Containers at Mellon Institute; Brasseur, Young Belgian Scientist, to Work with Langmuir Prize Winner; Grasselli Medal to L. V. Redman; Professor Desch to Lecture at Cornell under Baker Foundation; Pittsburgh Section, A. S. S. T., Sponsors Metallurgy Course; Metallurgical Advisory Board Holds Annual Meeting at Carnegie Institute of Technology..... 2301

Recent Books:

ENGELDER, "A Laboratory Manual of Gas, Oil, and Fuel Analysis" (*Reviewed by A. H. Gill*)..... 2302
BALLENTINE, "The Macmillan Table Slide-Rule" (*Reviewed by L. E. Steiner*) 2303
DOBBIN, "The Collected Papers of Carl Wilhelm Scheele" (*Reviewed by Ralph E. Oesper*)..... 2304
COCHRANE, "Lavoisier" (*Reviewed by Lyman C. Newell*)..... 2305
MILLARD, "Physical Chemistry for Colleges" (*Reviewed by T. F. Buehrer*).. 2305
MAASS AND STEACIE, "An Introduction to the Principles of Physical Chemistry" (*Reviewed by Martin Kilpatrick, Jr.*)..... 2307



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ALBERT ABRAHAM MICHELSON

EDITOR'S OUTLOOK

Albert Abraham Michelson, 1852–1931

WHEN Albert Abraham Michelson, shortly before his death at Pasadena, California, on May 9 last, dictated an outline of the results of his latest experiment on the measurement of the speed of light, he was recording the extension of a work begun as a fledgling scientist more than fifty years before, when, as instructor in chemistry and physics at the U. S. Naval Academy, with apparatus improvised from the rudest materials, he repeated with surprising accuracy the velocity experiment of Foucault. At the time of this youthful achievement, he was an officer in the Navy, but the young man had scarcely become an ensign when he began also to be a physicist. A rapidly growing interest and success in science soon enabled him to find himself; by 1880 he had left the Navy and, definitely committed to research, had become at the age of twenty-eight America's best-known physicist. Throughout his life Michelson never gave over the effort to strengthen the reliability of his determination of light speed; in 1927, with a beam of light traveling to a revolving mirror twenty-one miles between mountain peaks, he calculated it to be 186,286 miles per second, the most accurate measurement ever made; and shortly before he died he had the gratification of knowing that the results of measuring light in a mile-long vacuum buried in the earth, in order to be free of atmospheric effects, would further accredit his previous estimates.

Not less important or renowned than Dr. Michelson's work on velocity was that on light interference. This began in 1882, was continued in his famous collaboration with Professor Morley, and resulted in the development of the interferometer, which was used in Michelson's ether-drift experiments, his analysis of the structure of spectral lines, and in the direct measurement of the diameters of the stars.

In the course of his solution of these scientific problems, Dr. Michelson became a skilled inventor of physical apparatus, particularly in the line of optical instruments, his name being notably associated with the Michelson-Stratton harmonic analyzer, the echelon spectrograph, and the U. S. naval range finder, which last he developed during his return to service with the Navy during the World War.

Throughout these and other phases of the work of his long career, it was his thirst for precision in physical measurements to which Millikan, the pupil who came to be his friend and associate of many years, has referred "Michelson's economic value." To it Einstein has ascribed his first stimulus toward the theory of relativity and in less direct ways it has started the train of much recent and contemporary scientific thought.

Michelson was a Prussian by birth—he was born in Strelno on December 19, 1852—but he was brought to America by his parents during infancy. He grew up in San Francisco, whose public schools he attended.

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In 1873 he graduated from the U. S. Naval Academy, to which, after a two-years' cruise, he returned as an instructor. In 1879 he was moved to the Nautical Almanac Office in Washington, where, for a year, he assisted Professor Simon Newcomb on light experiments. At the end of this time he took a year's leave of absence for the purpose of working in European laboratories. The year in Europe stretched into two and took him to the laboratories of Helmholtz and Quincke in Germany, and of Cornu, Mascart, and Lippman in France. In 1881 he resigned his Naval commission and became professor of physics in the Case School of Applied Science. From 1890 to 1892 he occupied the chair of physics at Clark University, whence he was called to his final academic appointment, the headship of the department of physics of the University of Chicago. There he remained until his resignation in 1929, having held also during the preceding four years one of the institution's distinguished service professorships. The work which he carried on during the last years of his life was performed in the capacity of research associate of the Carnegie Institution of Washington.

This long career of scientific activity was attended from beginning to end by the gratification that comes from the fair and generous recognition of associates and of men and institutions of similar interests. The scientific societies of his own and other countries honored themselves by receiving him into membership. He served as president of the National Academy of Sciences from 1923 to 1927 and was a member of the American and British Associations for the Advancement of Science, the International Committee of Weights and Measures, the American Physical Society, the American Philosophical Society, the Royal Institution, l'Académie des Sciences, the Reale Academia Nazionale dei Lincei, and of others too numerous to record in a brief sketch. He was the first of Americans to attract a Nobel prize in science—this award in physics was given him in 1907 for "his optical instruments of precision, and the spectroscopic and metrologic investigations which he carried out by means of them."

The refinement of precision which marked Michelson's scientific work seems to have been an outgrowth of character which made itself apparent in other ways. In his personal dealings he was better known for justice than for generosity. Too discriminating to be expansive, he was nevertheless genial with all who sought a reasonable contact with him, and no better commentary could be made on his own contribution to his friendships than by calling attention to the fact that the associates and assistants of his latter days had maintained their connection with him for many years, and that these looked upon his death with deepest regret for a personal relationship broken all too soon, rather than as the ending of a life-work run to a beautiful completion.

The Philosophy of Grading

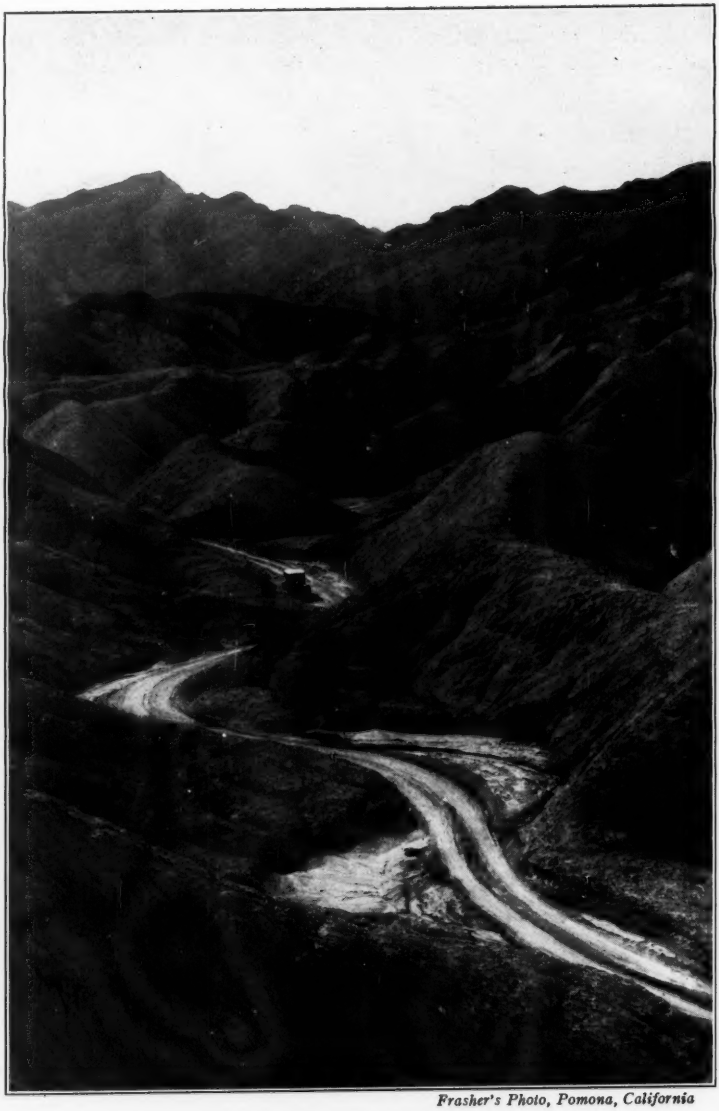
THE paper by T. B. Homan and Harold C. Hodge, read at the Indianapolis meeting of the Division of Chemical Education and published in the October, 1931, number of THIS JOURNAL, demonstrated nothing not already well known to students of education. As a study of the reliability of examination marks it was, perhaps, superfluous, but as a revelation of teacher psychology and teacher philosophy it has points of considerable interest.

What is the proper function of the examination or graded quiz in the general system of instruction? Should the examination be a purely clinical test—*i. e.*, should it be as nearly as possible a quantitative measure of the patient's condition? For purposes of educational research and for administrative guidance in teacher-evaluation there can be no question that this is the ideal to be aimed at. But is the ordinary classroom test solely, or even chiefly, diagnostic in purpose?

The diagnostic test implicitly assumes that there is no reaction upon the examinee—or at least disregards such reaction as there may be. Most teachers of the older school, and many of the newer, are fully aware that the examination or graded quiz may have a considerable effect upon the student and they usually plan and grade their questions with a view to making that effect as salutary as possible. To them the examination is an instrument of instruction—many of them will maintain that in a moderate-sized class no test can tell them a great deal that they do not already know about their students. From this standpoint the grading of tests becomes considerably more an art than a science.

It is in consideration of the psychological effect of the grade upon the student that teacher philosophies exhibit the widest divergency. Should the grade be a reward for achievement? If so, should it be based upon results alone (*i. e.*, solely upon the correctness or incorrectness of the answer to a numerical problem, for instance) as material rewards are based in later life, or should the era of poetic justice be extended from the home into the school and credit be given for honest and fairly intelligent, though futile, effort? If the grade is to be a reward based upon results alone, what shall we do with the student who works a problem wrongly, but, by mutual cancellation of errors, arrives at the correct answer? If poetic justice is to be meted out, is the brilliant student who turns in an average paper entitled to the same grade as the dull student who, by reason of extraordinary application and industry, also turns in an average paper? Or should the test and its grade be considered, not as task and payment, but as a means of aiding the student to diagnose and correct his own shortcomings?

We have our own opinion on these questions, but we have little doubt that any of the points of view here suggested, if consistently adhered to by a sincere believer in it, will lead to good results.



Frasher's Photo, Pomona, California

CORKSCREW CANYON, DEATH VALLEY

THE BORAX INDUSTRY IN SOUTHERN CALIFORNIA

W. F. Dingley, Pacific Coast Borax Company, New York City

Borax has been an important article of commerce since ancient times. It is a compound of sodium oxide and boric oxide, having many unique chemical and physical properties, which make it useful to various industries. Discoveries of deposits of crude borax and borate minerals in desert regions of Southern California, about 1880, led to exploitation and large-scale production of borax and boric acid and consequent availability of these products to industries at low prices. Demand has constantly increased and mining and refining operations have improved. While production has, for the most part, been from mines near Death Valley, there have recently been found large deposits of a new mineral called Rasorite, in the Mojave desert. Among the important industries using borax or boric acid are: enamelware, glass, pottery, leather, metal-working, glue, paints, textiles, cosmetics, pharmaceuticals, and others.

. . . . . .

Introduction

Tincal, "Cotton-ball," Ulexite, Colemanite, Rasorite—names little known to the average person—are names by which the progressive development of the borax industry in Southern California can be traced. Borax, known and used in ancient times on account of its characteristic properties, is now more in demand in the world than ever before. This interesting substance is the basis of one of the outstanding industries of the country. The history of the conquest of the West holds no more romantic story than that of the growth and expansion of an industry that has become famous through its association with Death Valley. Many articles have been written about this fascinating region, and of the tales and legends so closely woven into the early discoveries of borax. In this article we shall confine ourselves to those features bearing on the development of the world's greatest supply of borax. So vast are the present known deposits of borate minerals in Southern California, that this region seems destined to be the chief source of supply for many years to come.

Chemical and Physical Properties

Borax is a compound of sodium oxide and boric oxide having the formula $Na_2B_4O_7.10H_2O$. It is also referred to as sodium biborate or sodium tetraborate, depending upon whether one refers to the so-called molecular or atomic proportions. Boric oxide has the formula B_2O_3. Two molecular proportions of this oxide combining with one of sodium oxide (Na_2O) form anhydrous borax. Usually, borax crystallizes from water solution with ten molecules of water, but the pentahydrate can also be crystallized from solutions of certain concentrations and temperatures. Boric oxide (B_2O_3) combines with three molecules of water to form boric acid, which has the formula H_3BO_3. Boric acid is a relatively weak acid, and is displaced from

its salts by stronger acids; thus borate minerals, which are chiefly sodium and lime borates, can be readily decomposed with acids such as hydrochloric or sulfuric. Borax and boric acid and many borate minerals found in nature form well-defined crystals. Borax is weakly alkaline, but it will combine with an additional molecule of sodium oxide to form sodium metaborate, sometimes called monoborate, which has the formula $NaBO_2 \cdot 4H_2O$. When heated rapidly, borax swells and melts in its water of crystallization, but finally loses all this water and fuses to a clear glass at red heat. Similarly anhydrous boric acid, boric oxide, can be made by heating crystalline boric acid to remove the water of crystallization. Borates of the alkali metals are soluble in water in varying proportions; borates of other metals are relatively insoluble in water.

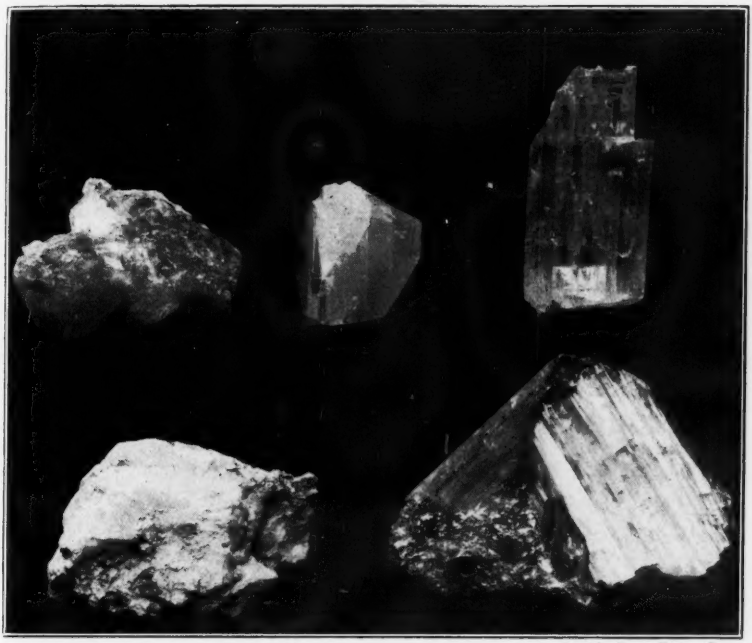
Early History

Very brief reference to the beginnings of borax recovery in the United States points to the year 1856 (*1*) when Dr. John A. Veatch found that he could evaporate the waters of certain springs near Red Bluff, California, and crystallize borax from the concentrated solutions. Later, in 1864, Dr. W. O. Ayres, associated with a company, treated similarly water from Clear Lake, California, and succeeded in producing small commercial quantities of borax. A real borax industry seems to have started in 1872, when the famous deposit at Teele's Marsh, Nevada, was discovered by F. M. Smith. This marsh yielded a large tonnage of crude borax over a period of years, and was the first commercially profitable deposit. Other deposits were worked at Rhodes Marsh, Nevada, and Searles Marsh, California, yielding crude borate of soda.

Death Valley Borax

In 1880, the salt crust marshes of Death Valley were found to contain crude borax. The Harmony Borax Works and the Amargosa Borax Works were erected to recover the material. It was during the years when these Death Valley marsh deposits were being worked that the historic and famous twenty-mule teams were made use of. Although these teams with their huge wagons have now become legends of the past, they were, nevertheless, for over twenty years, the basic means of transporting borax from Teele's Marsh to Wadsworth, Nevada, and from Death Valley to Mojave. The latter haul covered a distance of 167 miles, 60 miles of which was over country without water. Twenty mules, trained to the task, hauled two giant wagons and a water tank. The wagons weighed about 7800 lb. each, the water tank carried 1200 gallons and each wagon held 10 to 12 tons of borax. The load pulled by the mules often amounted to 70,000 lb. (the capacity of a modern freight car).

When the marsh borate deposits were first found, the real source of the borax was not known, other than that the salt crusts resulted from evapora-



Pacific Coast Borax Co.

BORON MINERALS

Colemanite Colemanite Rasorite
Ulexite Rasorite

tion of waters carrying borax. Later, when deposits of borate minerals were discovered in the mountains surrounding Death Valley, it seemed evident that the area contained boron minerals of various characters, but the origin of the borate deposits is more or less a matter of speculation. Much of the borate in the marsh deposits was crude borax, although sometimes a part of the water of crystallization had been driven off by the heat of the sun. Some was in the form of a light fibrous material called "cotton-ball." This is a form of the mineral Ulexite, a double sodium-calcium borate having the formula $NaCaB_5O_9.8H_2O$. The crude borate of soda was worked first, because it was readily soluble; no means being then known for converting the cotton-ball into borax. Later, however, it was found that by mixing cotton-ball with the natural soda (trona) occurring in the marshes, a reaction took place which yielded borax in solution. When the mineral deposits in the mountains were prospected Ulexite was found in quite a different form, associated with other borates and occurring in compact masses by itself.

Colemanite Discoveries

For a time it was believed that the dry lake marsh deposits were the only natural sources of borax in this country. This idea was soon changed, however, by the discovery of extensive deposits of calcium borate, having the formula $Ca_2B_6O_{11}.5H_2O$. This mineral was named Colemanite, after Wm. T. Coleman of San Francisco. The first discoveries of Colemanite were in Furnace Creek Canyon in the Funeral Mountains, bordering Death Valley. Somewhat later other Colemanite deposits were found in the Calico Mountains, near Daggett, California, and mining was started at the Calico deposits on account of their nearness to the railroad. For about eighteen years, these deposits furnished a large proportion of this country's borax supply, the mineral being shipped to Alameda, California, for refining.

Production Extended

The ever-increasing demand for borax soon made it evident that greater production was necessary, and, as the Calico deposits were worked out, mining was again transferred to the Death Valley vicinity, this time operations being first undertaken at the Lila C mine, where Colemanite was the ore, and, as the market demand increased, mining was extended to other properties in the Funeral Mountains, the ores worked being chiefly Colemanite and Ulexite. Opening up these deposits required better transportation than could be maintained by the twenty-mule teams, and a railroad was built from the Santa Fe Junction at Ludlow extending north to Beatty, Nevada. This road was called the Tonopah and Tidewater Railroad and was the first railroad to penetrate the Death Valley region. It was built in record time, in spite of difficulties due to severe climatic conditions and the rough character of the country over which the road was laid. From Death Valley Junction, on the Tonopah and Tidewater line, a narrow gage line was built to the mines and finally the transportation system included a baby gage, connecting the mines with the ore storage bins. Development of refining operations kept pace with mining. A large concentrating plant was erected at Death Valley Junction, and what was then the largest refinery in the world was built at Bayonne, N. J. For many years, these Death Valley deposits of Colemanite and Ulexite supplied a large part of the world's borax requirements.

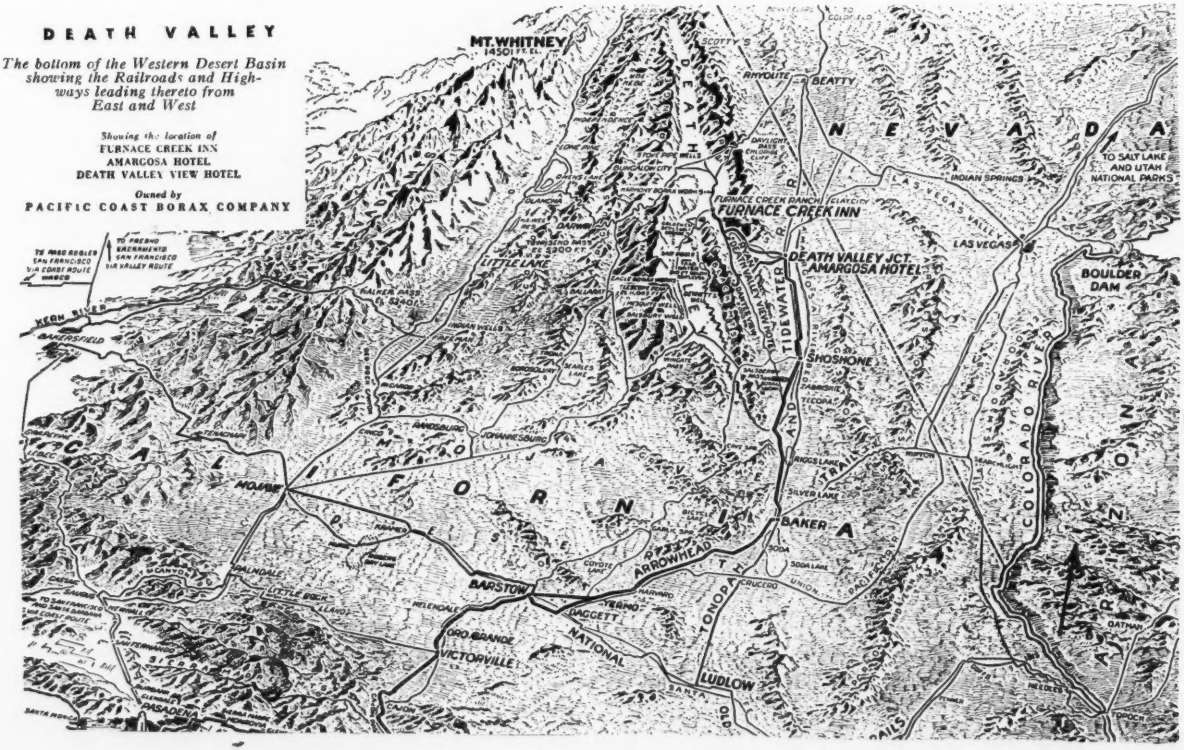
From the time of borax discoveries in the desert dry lakes, on through the exploitation of the Death Valley deposits, the progressive history of the borax industry has been the history and growth of the pioneer company which undertook to extend industry into this remote region. During the past half century, the Pacific Coast Borax Co. has carried on mining, refining, and manufacturing of borax, boric acid, and related products.

DEATH VALLEY

The bottom of the Western Desert Basin showing the Railroads and Highways leading thereto from East and West

Showing the location of
FURNACE CREEK INN
AMARGOSA HOTEL
DEATH VALLEY VIEW HOTEL

Owned by
PACIFIC COAST BORAX COMPANY



Willard, Palm Springs, California
LOOKING ACROSS DEATH VALLEY TO TELESCOPE PEAK (11,045 FT.) FROM GOLDEN CANYON

Borax in Lake Brines

Aside from the extensive mineral borate deposits in Southern California, there has been considerable interest in the brines of Searles and Owens Lakes. These brines have long been known to carry valuable amounts of soda, potash, and borax. The chief interest, in recent years, has centered in the recovery of potash, and economical methods of potash recovery from these brines usually involve recovery of borax also. From time to time, a number of companies have operated on these lakes for recovery of soda, potash, and borax, and the lakes are a potential source of borax when there is ready market for the other products. To date extensive developments in recovery of these materials have taken place.

Rasorite, Latest Discovery

Coming down to the present, the most important recent development in the borax industry has been the discovery of the new mineral Rasorite, named after C. M. Rasor, Mining Engineer of the Pacific Coast Borax Company. This new mineral is also known as Kernite. Principal deposits of Rasorite are located near the town of Kramer in the Mojave desert. The most interesting fact concerning Rasorite is that it is a crystalline

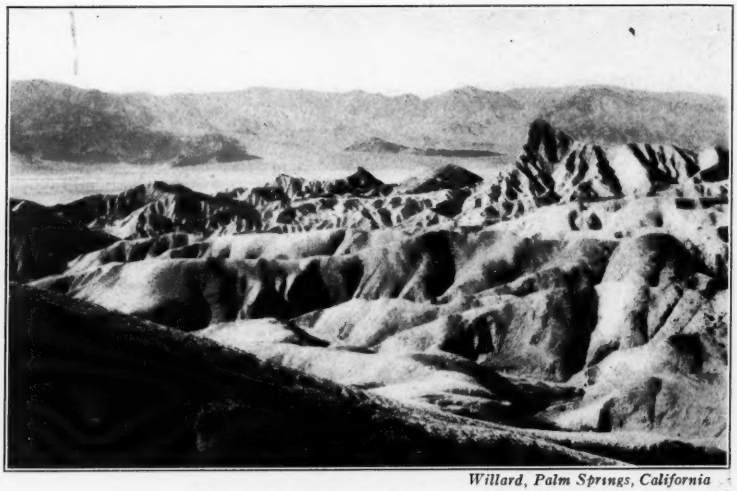
Pacific Coast Borax Co.

FURNACE CREEK WASH, DEATH VALLEY

hydrate of borax never known to exist prior to the discovery of these deposits of it. Theoretically, the mineral has the formula $Na_2B_4O_7 \cdot 4H_2O$—the water content being a characteristic difference from borax. Rasorite is found at a considerable depth below the surface, which is also somewhat in contrast with deposits of other borates. The mineral is associated with crude borax, tincal, and with strata of shale and clay. While similar to borax in molecular ratio of soda to boric oxide, Rasorite proved to have physical properties quite different. A feature of interest to the scientist is the fact that fully two years prior to the discovery of this new mineral, the possible existence of borax in this new form was predicted by Geo. A. Connell, Chemical Engineer with the Pacific Coast Borax Company, in connection with researches made by him. The discovery of Rasorite deposits marks the latest stage in the development of the borax industry. The accessibility and workability of these new deposits have already brought about a discontinuance, for the present at least, of mining operations at the Death Valley Colemanite deposits. Developments and economies in mining and processing Rasorite have been, to a large extent, responsible for reduction in the price of borax and boric acid to present low figures.

Borate Area

Geographically the California borate deposits (*2*) are located within a relatively small area, although this area is large enough to hold very



Willard, Palm Springs, California

DEATH VALLEY FROM ZALRISKIE POINT

extensive deposits. Exploration and mining operations disclose ore bodies at widely separated points. Stated approximately, the principal deposits are within the desert area bounded on the west and south by the Sierra Nevada and Sierra Madre mountains and on the north and east by the Nevada-California boundary. This area includes the Death Valley vicinity and the Mojave desert. The new deposits of Rasorite, which remained for so many years undiscovered, are also within this area. Some deposits are also known further west at Lang, north of Los Angeles, and outcroppings have been found westward to the Pacific Ocean.

The geologic features of the Southern California borate deposits have been described in great detail by Keyes in *Bulletin of the American Institute of Mining Engineers*, October, **1909.** Generally speaking, the borate beds are interstratified with soft clays and sandstones. The beds in the Death Valley vicinity have been exposed by extensive faulting, and there are many evidences of volcanic action in the character of the rock formations in the district. Principal borate minerals, referred to here only by name are described in detail by Schaller. (*3*)

Concentration and Refining

In general all processes for making borax depend upon first producing a solution from which the borax can be crystallized. All commercially workable deposits of borate minerals yield ore, which contains the borate mixed with clay, shale, limestone, or other natural impurities. On account of the desirability of transporting as little waste material as possible from

Willard, Palm Springs, California

THE "DEVIL'S GOLF COURSE"—DEATH VALLEY

the mines, it has been customary to concentrate the borate minerals and to ship the concentrated mineral to refineries for further conversion into borax. Concentration processes have been developed to work the various types of mineral and gangue associations, and new departures in mining, concentrating, and refining have frequently been necessary. The mineral concentration has been one of roasting the ore and subsequently separating the gangue from the borate by screening and air-classification. In treatment of its ores, the Pacific Coast Borax Company was one of the first to make use of dry concentration methods and now these methods have reached a high degree of development.

At the refineries the minerals are treated to dissolve them. When lime borate ore is used, proper amounts of soda have to be added to react with the borate and convert the lime borate to borax. When crude sodium borates are available, the process is one of dissolving the crude material under suitable conditions. The process liquors carrying borax in solution are clarified by settling or filtration and liquors run to crystallizers. Crystallization processes depend upon the fact that borax is very soluble in hot solutions, but crystallizes out when the solutions are cooled. This fact, coupled with other physical characteristics of borax, makes it possible

to vary the size of the borax crystals by regulation of the rate and conditions of cooling.

Boric acid may be made directly from borate minerals, or from borax, by treatment with a suitable acid. In present practice sulfuric acid is used on account of its lower cost. Boric acid is also more soluble in hot than in cold liquors and, after purifying the liquors, boric acid is separated by cooling.

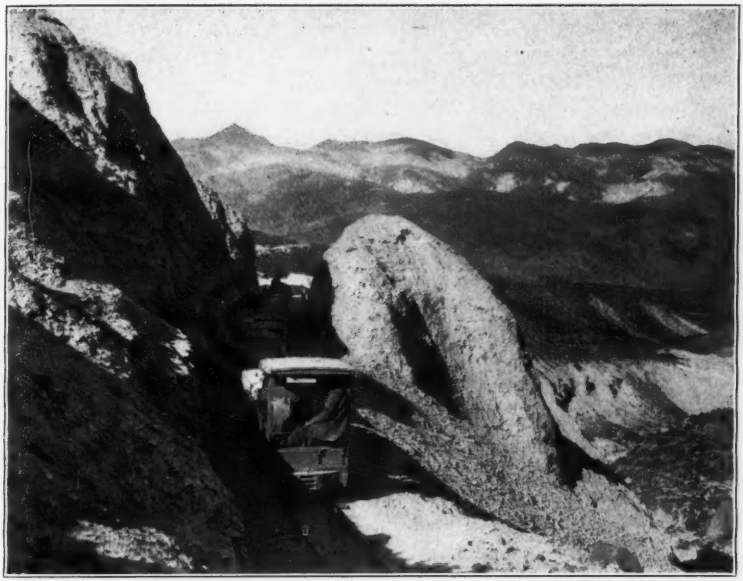
The Pacific Coast Borax Company has recently erected at Wilmington, California, a plant which embodies the most modern improvements both in construction and in design of refining and production equipment. This plant is now the largest and most up-to-date borax and boric acid plant in the world. The facilities also include a completely appointed chemical laboratory for control and investigation into production and uses of the company's products.

Industrial Uses

No statement relative to the borax industry would be complete without reference to the widespread and varied uses to which borax, boric acid, and related products are put. Hardly any other substance enters into so many varied lines of manufacture. No simple outline of properties can account for the variety of reactions in which these products take part. The potter, the enameler, the metallurgist, the glass and tile maker, and the tanner would be greatly handicapped without either borax or boric acid. They are used extensively in the manufacture of cosmetics, textiles, inks, paints, varnishes, glues, and washing compounds and are of definite service to braziers, jewelers, and pharmacists. With the prices of borax and boric acid so low, many are seeking to take advantage of their unique properties in new lines of manufacture. A brief summary of the more important uses for these products may be of interest to some and may be suggestive of other ways of putting them to work.

In metal working, both borax and boric acid are used as fluxes. In brazing, welding, soldering, etc., fluxes dissolve metallic oxides and thus clean the metal surfaces. Borax and boric acid are especially serviceable in working cast iron, steel, copper, brass, bronze, etc. Borax is also used in smelting copper and in refining gold and silver. Certain borides are made use of as deoxidizers for metal melts. Boron has a marked affinity for oxygen.

In the modern home the brilliant, white-enameled basins, sinks, and bath tubs and the artistically colored table tops, stove parts, and enameled utensils all owe their attractive surfaces to borax and boric acid. No other substance has been found which can satisfactorily and economically replace boric oxide in enameling. Most enamels contain a considerable proportion of borax. In fact, the modern enamel industry could hardly have reached



Pacific Coast Borax Co.

MODERN BORAX TRANSPORTATION

its present development without the large-scale production of borax and its availability at a low price, made possible by the exploitation of the Death Valley borate deposits.

In pottery glazes boric acid is more generally used, but both boric acid and borax are used in frits for glazing earthenware, tile, brick, etc.

The use of boric oxide in the manufacture of glass is a use of long standing in making special heat-resisting and optical glasses. More recently bottle and container manufacturers and makers of the more common types of glassware have taken up the use of small percentages of boric oxide. Boric oxide can be introduced into glass either in the form of borax or boric acid. Extensive theoretical and practical studies have established the value of varying amounts of boric oxide in glass for various purposes. Generally speaking, boric oxide in glass lowers the coefficient of thermal expansion, affording greater resistance to temperature changes. It increases resistance to mechanical shock and improves tensile strength, thereby giving a more durable glass. It gives a more stable surface with increased resistance to weathering. In the glass-making process boric oxide tends to lower the melting temperature, increasing the rate of fining and promotes increased glass tank output.

In the production of leather both borax and boric acid find use at various

points in the processes. In the soaks borax is used as a water softener and hastens cleansing of hides and skins. The mildly antiseptic character of borax prevents putrefaction in the soaking baths and stops growth of molds upon the hides. Boric acid, because of its mild acidic character, is an excellent deliming agent, capable of producing a soft, smooth grain in the finished leather, without swelling or injury to the pelt. Borax is again used in neutralizing free acid in leather tanned with chrome salts. In dyeing leather, borax is useful in facilitating penetration of the dye and producing an even color.

The textile industry uses borax. It is a safe agent for degumming or "boiling-off" silk. In all sorts of laundering, washing, cleaning, and dyeing processes, borax has applications. The uniformity of color in dyeing frequently depends upon a constant pH in the dye bath. Borax and boric acid in solution are good "buffers." There are important advantages in washing fabrics with solutions containing borax, especially woolens, silks, rayons, and colored goods. Borax is an excellent detergent, but is, at the same time, harmless to any fabric, and is a safeguard against alkali damage. The pH of many so-called neutral soap solutions can often be reduced by addition of borax. In starches and sizes borax not only improves the finish, but also prevents mold or mildew.

Adhesives are made from a variety of materials. Borax can be used to advantage in making glue and mucilage. It is also a solvent for dextrine and casein and is at the same time non-corrosive. Many pastes contain boric acid as a preservative.

A somewhat kindred use for borax is found in the preparation of sizes and coatings for enameled, glazed and art paper, playing cards, etc., where it is used as a solvent.

Considerable investigation has been carried on from time to time to develop fireproofing preparations for wood, paper, and fabrics. Many of the best of such compounds contain borax or boric acid or both. Mixtures of borax and boric acid have been shown to have good fireproofing ability when applied to fabrics.

And so we might continue to include other uses, such as hairwaving, electro-plating, manufacture of insect repellents, soap-making, mold prevention, industrial cleaning, jewelry manufacture, etc. The borax treatment of citrus fruits is an important illustration of mold prevention.

Related Products

Several other products of the borax industry ought to be referred to. Borax glass is anhydrous borax made by fusing borax and driving off the water of crystallization. Calcined borax is made by heating borax, to drive off the moisture, at a temperature below the fusion point. Anhydrous boric acid is really boric oxide and this is made by fusing boric acid to drive

off the water of crystallization. These products have special applications in certain industries.

Manganese borate is a product used as a drier in the manufacture of drying oils, varnishes, printing and stamping inks. It can be made from borax and compounds of manganese. Some years ago there was offered on the market considerable manganese borate, which was merely a mixture of manganese salts with borax and various fillers. Due to activities of the Pacific Coast Borax Co. in producing a real compound, the trade now insists on having material in which the manganese is combined as borate.

Ammonium borate finds use in hairwaving and in certain types of electrolytic rectifiers and condensers.

Various other borates are known and can be produced commercially, but have not yet come into use in industry.

Borax, a Household Cleanser

While Southern California has supplied the demands of manufacturing industries for borax, it has also supplied the increasing demands of the homes of the country for household packages. Surveys indicate that over two-thirds of all the homes in the country use borax for one purpose or another. It is a safe, efficient cleanser and an aid to soap in every sort of household cleaning. Its special properties are well recognized by those who have learned to use it. And boric acid is fully as important a household necessity as borax.

The borax industry is still expanding and it will continue to grow with the demand for its products. It is an industry producing materials essential to many other industries. Its future is, therefore, closely tied up with progress of the consuming industries, and in development of new outlets.

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Atoms Are Wanderers Even in Solid Metal. Atoms, even the heavy atoms of lead, are wanderers. Prof. J. G. von Hevesy, of the University of Freiburg in Breisgau, has been investigating their properties. Lead atoms are constantly in motion, even in solid metal, he believes. In an alloy of lead and gold, at a temperature half again as high as that of boiling water, the atoms wander through a space of a hundredth of a cubic inch in a day. When there is nothing but lead in the lump, however, moving about is not nearly so easy; in pure lead an atom can migrate in one day through a space of only two-ten billionths of a cubic inch.—*Science Service*

THE AMPHOTERIC ELEMENTS AND THEIR DERIVATIVES: SOME OF THEIR PHYSICAL AND CHEMICAL PROPERTIES*

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The amphoteric elements act electropositively toward more electronegative elements and electronegatively toward more electropositive elements. They include all elements of the 4th, 5th, 6th, and 7th groups having a deficiency of from four to one electron(s) with respect to the rare gas configuration. Compounds of amphoteric elements with more electronegative elements are not ordinarily salts; compounds of the amphoteric elements with strongly electropositive elements are generally salts. These salts are usually of the poly type and appear to be highly ionized. Such salts of lead, tin, antimony, bismuth, tellurium, etc., are known.

The amphoteric elements quite generally combine with hydrogen and with hydrocarbon groups. In the case of amphoteric elements of higher valence, if all but one or two of the valences are satisfied by means of hydrocarbon groups, the remaining valences are amphoteric in their behavior. The compounds of such amphoteric groups with strongly electronegative elements are not generally true salts, but the compounds of such groups with strongly electropositive elements are salts. The ionization of these salts in liquid ammonia solution is often higher than that of ordinary salts, such as sodium bromate, for example. The larger the substituent groups attached to the amphoteric atom, the greater is the ionization of the salt.

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Simple Compounds of Amphoteric Elements

THE AMPHOTERIC ELEMENTS

As may be seen from a table of the periodic system, the rare gases, which are chemically inert, divide the highly reactive, electropositive, metallic elements from the highly reactive, electronegative, non-metallic elements. According to our present conceptions, the atoms tend to lose or acquire electrons in such number as to build up an external shell of eight electrons, corresponding to that of the rare gases. This results in the formation of positive or negative ions in the case of the more extreme members of the two series. We thus have two groups of elements, the electropositive and the electronegative, which, in general, are sharply distinguished from each other in their chemical and physical properties.

There is, however, a considerable group of elements which form several distinct types of compounds, namely: compounds in which the elements in question function negatively and other compounds in which they function positively. Thus we have iodine functioning as a negative ion in the iodides, while in its oxygen acids it functions positively. In general, the elements of the 7th, 6th, 5th, and 4th groups of the periodic system, that

* Dohme lecture, delivered at The Johns Hopkins University on May 8, 1931.

have a deficiency of from one to four electrons over that of the rare gas configuration, are capable of acting in a dual capacity. In the presence of more strongly electronegative elements, they act electropositively, that is, lose electrons, while in the presence of more electropositive elements they act electronegatively, that is, take up electrons. These elements we shall call amphoteric. They include all the elements of the 4th, 5th, 6th, and 7th groups and hydrogen.

It is probable that the elements of the 3rd and 2nd groups, having a deficiency of five and six electrons, respectively, with respect to the rare gases, likewise possess amphoteric properties, but they do not exhibit these properties as uniformly as do the elements of the succeeding groups mentioned above and they will, accordingly, only be touched upon incidentally in the present discussion.

PROPERTIES OF THE AMPHOTERIC ELEMENTS

In their physical properties, the amphoteric elements differ very widely. Thus, some are permanent gases while others are very high-melting solids. About half of them are non-metallic elements and the remaining half are metallic. They have in common this one property, namely: they do not exist in monatomic form as vapors except at very high temperatures. The lighter elements of higher valence and all the univalent elements exist as diatomic molecules in the vapor state; the heavier elements of higher valence form more complex vapors.

The properties of the amphoteric elements vary regularly with atomic number in a group or in a period. Their reactivity increases as the atomic number diminishes in a group or increases in a period. So, also, the elements become more metallic as the atomic number increases in a group or decreases in a period. The amphoteric elements exist in three states of oxidation: (1) as neutral elements, (2) as electropositive constituents of compounds, and (3) as electronegative constituents of compounds. We shall now discuss the properties of the compounds just mentioned as a function of the electron affinities of the constituent amphoteric elements.

COMPOUNDS IN WHICH AMPHOTERIC ELEMENTS ACT ELECTROPOSITIVELY

We are, on the whole, more familiar with compounds in which the amphoteric elements act electropositively than we are with those in which they act electronegatively. Practically all the amphoteric elements form compounds with strongly electronegative elements such as chlorine or fluorine. It may be stated at this point that as an element is more electronegative, it is less electropositive. Of the amphoteric elements, fluorine is the most electronegative and least electropositive. If A^n is an amphoteric element of valence n, which supplies electrons to a strongly electronegative, univalent element X, then the properties of the compounds of the type

A^nX_n will vary between those of semi-polar compounds, such as the halogen acids or stannic chloride, and non-polar compounds, such as sulfur hexafluoride and sulfur dioxide, for example. In the case of the more electropositive amphoteric elements, such as hydrogen, tin, lead, and bismuth, the compounds with the halogens are not true salts and are, therefore, not electropolar; for, in the pure state, they are not good conductors of the electric current. On the other hand, many of these compounds when dissolved in suitable solvents exhibit more or less marked electrolytic properties. This is true of the acids, for example, which often are excellent electrolytes in water and other basic solvents but are poor electrolytes when dissolved in non-basic solvents. The electrolytic properties of the acids are due to reaction of the protons of the original hydride with the solvent molecules, hydrogen ions being formed. When two amphoteric elements of nearly equal electron affinity combine, they ordinarily form non-polar compounds. This is the case, for example, with sulfur dioxide, methane, etc.

Many compounds are formed between the more electronegative of the amphoteric elements in which the atoms are coupled by non-polar bonds but where a group of atoms, as a whole, has a definite negative valence. This is the case, for example, in the oxygen acids of the halogens, sulfur, nitrogen, etc. The amphoteric element in these compounds acts electropositively. This is well illustrated by the reaction of the amphoteric elements with hydroxy bases. Thus, chlorine reacts with potassium hydroxide according to the reaction equation:

$$Cl_2 + 2KOH = KCl + KOCl + H_2O.$$

One of the chlorine atoms has been reduced to a chloride ion while the other has been oxidized to hypochlorite. This type of reaction holds generally for the amphoteric elements, although it is studied more readily in liquid ammonia than in aqueous solution.

COMPOUNDS IN WHICH THE AMPHOTERIC ELEMENT ACTS ELECTRONEGATIVELY

With very few exceptions, the amphoteric elements act electronegatively in the presence of strongly electropositive elements. Compounds of the type M_nA^n, in which M is a univalent electropositive element, such as an alkali metal, and A^n is an amphoteric element of valence n, are commonly formed by the amphoteric elements with the exception of carbon and perhaps silicon. When the amphoteric element A is strongly electronegative, the compounds are known to be electropolar. As examples may be mentioned the salts of the various halogen acids. As the amphoteric elements are less electronegative, the compounds are less stable in the presence of water and oxygen. As a result of this circumstance, our knowledge of these compounds is very limited. This is especially true of such elements as lead, tin, germanium, bismuth, etc.

While compounds of oxygen corresponding to the formula M_2O are common, we know little about them, for they are invariably high-melting substances which are generally insoluble in all solvents. The same is true of the corresponding nitrogen derivatives M_3N. While nitrides are formed, they are not always stable at higher temperatures and we have no sure information as to their constitution.

Sulfur forms compounds M_2S which are electropolar. The fused sulfides exhibit electrolytic properties and they are sufficiently stable in aqueous solution to show that they are electrolytes in solution. However, the study of sulfides in aqueous solution is rendered difficult owing to the fact that the sulfides tend to hydrolyze with the formation of acid sulfides. The reaction is precisely similar to the hydration of oxides, in which hydroxides are formed. The sulfhydrate ions, like the hydroxyl ions, are examples of a type of compound which the amphoteric elements form quite generally and which will be discussed below.

As the amphoteric elements are less electronegative, their tendency to hydrolyze increases and our knowledge of them is accordingly limited. While phosphorus forms compounds of the type M_3P and tin forms compounds of the type Na_4Sn, these compounds are immediately and completely hydrolyzed by water and cannot be studied under ordinary conditions. Moreover, these compounds are ordinarily reactive toward oxygen.

POLY-SALTS

The tendency of compounds of the type M_nA^n to hydrolyze is, of course, dependent upon the properties of the solvent medium. If the affinity of the medium for protons is sufficiently high, hydrolysis will not occur. Liquid ammonia is such a solvent and has proved very valuable in studying compounds of the type now under discussion. The solubility of the simple compounds M_nA^n in liquid ammonia is low, but fortunately, they react quite generally with additional atoms of the amphoteric constituent to form soluble compounds of the poly-type. For example, sodium sulfide is difficultly soluble in liquid ammonia but it reacts readily with additional sulfur to form polysulfides according to the equation:

$$Na_2S + S_x = Na_2S_{x+1}$$

The polysulfides are extremely soluble in liquid ammonia and are true salts, that is, electropolar compounds. In general, with the exception of hydrogen, oxygen, nitrogen, carbon, and silicon, the amphoteric elements form compounds $M_nA^n{}_{x+1}$. Thus, lead forms the normal plumbide, Na_4Pb, which is insoluble in liquid ammonia. It reacts readily with additional lead to form the highly soluble polyplumbide, Na_4Pb_9.

It has been shown that the polyplumbides in liquid ammonia solution are electrolytes and, consequently, that the polyplumbides are electro-

polar (*1*). When sodium polyplumbide is electrolyzed between lead electrodes in liquid ammonia solution, nine atoms of lead are dissolved at the cathode and precipitated on the anode for every four equivalents of electricity passing through the solution. This shows conclusively that lead is present as a complex negative ion in which nine lead atoms are associated with four charges of negative electricity. It has also been shown that similar compounds are formed in the case of tin, germanium, antimony, bismuth, arsenic, and tellurium (*2*).

Bergstrom has shown that a more electronegative amphoteric element is capable of replacing a less electronegative amphoteric element from its salts (*3*). Thus, if metallic tin is introduced into a solution of sodium polyplumbide in liquid ammonia, lead crystallizes out while tin goes into solution. Similar replacement reactions occur with bismuth, antimony, arsenic, tellurium, etc. Bergstrom has thus set up the series: lead, bismuth, tin, antimony, arsenic, phosphorus, tellurium, selenium, sulfur, iodine, in which any element is replaced from its salts by a succeeding element.

It will be noted that some of the amphoteric elements appearing in this series are metals, while others are non-metals. The same is true of their compounds with more electropositive elements. Thus, while the compounds of the alkali metals with sulfur and selenium are non-metallic, the corresponding compounds with antimony, bismuth, tin, and lead are metallic. The compounds exhibit metallic properties when they are in the condensed state; in solution they are electrolytes.

Organic Derivatives of Amphoteric Elements

AMPHOTERIC GROUPS AND THEIR COMPOUNDS

The amphoteric elements, excepting the halogens, form amphoteric groups $R_{n-1}A^n$, where R is an organic group or hydrogen. A familiar example is triphenylmethyl, in which three of the valences of carbon are satisfied by phenyl groups, while the fourth valence remains active. Triphenylmethyl is a typical amphoteric group which, in solution, is largely associated to the dimer $(C_6H_5)_3C—C(C_6H_5)_3$. Triphenylmethyl acts as electron donor toward the more electronegative elements, such as the halogens, and as electron acceptor toward the more electropositive elements, such as the alkali metals. Thus, we have triphenylmethyl chloride, $(C_6H_5)_3CCl$, and potassium triphenylmethide, $KC(C_6H_5)_3$. The latter compound is a true electrolyte as we shall see presently. It may be looked upon as a salt of the acid, triphenylmethane $(C_6H_5)_3CH$, and the base, potassium amide, KNH_2.

Potassium triphenylmethide may be formed by the action of potassium amide on triphenylmethane in liquid ammonia, by the action of potassium on triphenylmethane in the same solvent, or by the action of potassium on triphenylmethyl in ammonia or other solvents (*4*). The reactions are:

$$(C_6H_5)_3CH + KNH_2 = (C_6H_5)_3CK + NH_3$$
$$(C_6H_5)_3CH + K = (C_6H_5)_3CK + {}^1/_2H_2$$
$$(C_6H_5)_3C + K = (C_6H_5)_3CK.$$

The last of these reactions is more properly written:

$$(C_6H_5)_3C + e^- = (C_6H_5)_3C^-,$$

where e^- represents an electron. All of the above reactions are quantitative and the first reaction is reversible. In a sense triphenylmethane exhibits acidic qualities.

The amphoteric elements quite generally form univalent groups of the type A^nR_{n-1}. These groups form compounds of the type $R_{n-1}A^nX$ and $R_{n-1}A^nM$, where X is a strongly electronegative element or group and M is a strongly electropositive element. In the case of carbon, groups of the type R_3C do not ordinarily exhibit amphoteric properties when the substituents R are alkyl groups because, in this case, the fourth valence of carbon has a very high affinity for hydrogen or for another carbon group. In the case of other elements, however, groups of the type $R_{n-1}A^n$ exhibit amphoteric properties quite generally. The amphoteric nature of such groups is more evident in the case of elements of higher atomic number.

Tin forms typical amphoteric groups, R_3Sn. We thus have trimethyl tin $(CH_3)_3Sn$, which, in solution at lower temperatures, exists as a dimer while, at lower concentrations and higher temperatures, it is measurably dissociated. With the halogens, trimethyl tin forms compounds $(CH_3)_3SnX$ and, with the alkali metals, salts $(CH_3)_3SnM$. Trimethyl tin iodide or chloride is not an electropolar compound, for it is a poor conductor of electricity in the pure state or in solution in many solvents of higher dielectric constant (*5*). It is ionized in aqueous solutions, although it is markedly hydrolyzed, since the base $(CH_3)_3SnOH$ has a dissociation constant of approximately 1.5×10^{-7}. Since the free valence of trimethyl tin possesses a relatively high affinity for an electron, we should not expect its compounds with the halogens to be true salts. Its ionization in water and similar solvents is due to reaction with the solvent medium, a complex cation being formed (*6*). Thus, with ammonia, the following reaction occurs:

$$(CH_3)_3SnX + NH_3 = [(CH_3)_3Sn\cdot NH_3]^+ + X^-.$$

Trimethyl tin chloride is not measurably ionized in aprotic solvents such as acetone, nitromethane, etc. (*5*).

As the amphoteric element is less electropositive, its compounds show correspondingly less tendency to ionize in solution and a greater tendency to hydrolyze. Thus germanium compounds of the type R_3GeX are poorer electrolytes than the corresponding tin compounds. In many respects, the univalent amphoteric groups are closely analogous to hydrogen. For example, their compounds with the halogens, like those of hydrogen, are

not electropolar and their solutions in acidic or neutral solvents are not electrolytes. When dissolved in basic solvents, they yield electrolytic solutions due to the formation of positive ions by combination with the molecules of the solvent medium.

The neutral amphoteric groups of the type $R_{n-1}A^n$ present numerous points of interest. The best known groups of this kind are derived from carbon and from nitrogen (7). There appear to be a few that are derived from oxygen. The neutral groups are ordinarily associated as dimers but, depending upon the nature of the substituents R as well as upon the nature of the central atom A, they are frequently more or less dissociated in solution and are commonly known as free groups. In the case of carbon, the triarylmethyl groups are well known and have been extensively studied. Corresponding carbon derivatives in which alkyl groups act as substituents commonly exist only in bimolecular form and the C—C bond is relatively stable. The substitution of alkyl by aryl groups weakens the C—C bond and when only aryl substituents are present the groups R_3C are commonly dissociated in solution. In the case of nitrogen, also, groups of the type R_2N exist in dimeric form and are frequently dissociated in solution when the substituents R are aryl groups. Certain of the organic peroxides exhibit a loose coupling of the O—O bond.

In the investigation of various amphoteric groups, attention has been largely directed toward those which are appreciably dissociated into the monomeric form in solution and little attention has been paid to groups in which the A—A bond is relatively stable. It is evident that no sharp line can be drawn between groups of the type $R_{n-1}A^n$ which are firmly bonded in the form of dimers and those which are largely dissociated. The difference between the two is one of degree rather than of kind and our knowledge of these groups will be greatly restricted if we confine ourselves to such as exist largely in the monomeric form.

DERIVATIVES OF ELEMENTS OF THE 4TH GROUP

The elements of the 4th group are particularly valuable in studying the properties of amphoteric groups as a function of the properties of the central atom. Not only do we have compounds of the type $R_3A—AR_3$, we also have mixed compounds $R'_3A—AR''_3$, $R_3A'—A''R_3$ and $R'_3A'—A''R''_3$. In general, the strength of the coupling of a pair of groups is the weaker the more electropositive the groups in question. Thus, the Sn—Sn bond is much weaker than the Ge—Ge bond and the latter, in turn, is much weaker than the Si—Si bond. It is of interest to note that in the case of tin the firmness of the coupling is not greatly influenced by the nature of the substituent organic groups R. Both trimethyl tin and triphenyl tin are largely associated to the dimeric form in solution in benzene near its freezing point. Trimethyl tin is known to be measurably dissociated into the

monomeric form in benzene near its boiling point. Similar data on triphenyl tin are not available but, since triphenyl tin is more stable toward oxidation than is trimethyl tin, it is reasonable to assume that the bonding in the case of the phenyl derivative is more stable than is that of the methyl derivative. Both the methyl and phenyl derivatives are readily oxidized by bromine and both are readily reduced by sodium in liquid ammonia.

In the case of germanium derivatives, the Ge—Ge bond is much more stable than the corresponding Sn—Sn bond. Triphenyl germanium and triethyl germanium are both stable toward atmospheric oxygen. Both are oxidized by means of bromine and both are reduced by means of the alkali metals in ammonia or ethylamine. The reduction, however, takes place much less readily than does that of the corresponding tin compounds. It is of interest to note that the group GeH_3 has much the same properties as $Ge(C_2H_5)_3$, except that its coupling is markedly less stable. It is readily reduced by alkali metals in liquid ammonia and it is oxidized by molecular oxygen at ordinary temperatures. In the gaseous state it exists as the dimer, GeH_6 (*8*).

When we come to silicon, we find that both triphenyl silicon and triethyl silicon exist in the form of very stable dimers. The Si—Si bond is not broken by oxidizing agents such as bromine nor by reducing agents such as metallic sodium in liquid ammonia.

DERIVATIVES OF ELEMENTS OF THE 2ND AND 3RD GROUPS

Organic groups of the elements of the 2nd and 3rd groups of the periodic system have not been extensively investigated. Compounds of the type $R_{n-1}A^nX$ are formed by numerous elements of the 2nd and 3rd groups, but these compounds are frequently unstable toward oxidizing and hydrolyzing agents. The derivatives of the heavier elements such as mercury and thallium are relatively stable. Methyl mercuric chloride, CH_3HgCl, for example, is readily soluble in water and is measurably ionized. It is considerably hydrolyzed, since the base CH_3HgOH has an ionization constant of only about 1×10^{-7}. In no case has one of these groups been reduced to the state of a negative ion and only in the case of the alkyl mercury derivatives have the free groups been obtained. It is interesting to note that, in the case of the lower alkyl derivatives, groups of the type CH_3Hg may be prepared by electrolytic reduction and that they are metals in the free state (*9*). Apparently, then, as the neutral groups of the type $R_{n-1}A^n$ become more electropositive, metallic properties appear. This is not unexpected, for, if the affinity of the group for an electron is sufficiently low, the compound should be a metal in the solid state.

DIVALENT AMPHOTERIC GROUPS

It may be pointed out that divalent groups of the type $R_{n-2}A^n$ also exist. Kraus and Greer (*10*) have studied the divalent group $(CH_3)_3Sn$

and Krause and Chambers and Scherer (*11*) have prepared the group $(C_6H_5)_2Sn$. In the free state, dimethyl tin is a highly reactive yellow solid which is doubtless highly polymerized. On the other hand, it has been possible to obtain diphenyl tin in a monomolecular form in benzene solution. It gradually polymerizes to an insoluble yellow solid. Dimethyl tin is a typical divalent amphoteric group. With the halogens it forms compounds $(CH_3)_2SnX_2$, which are ionized in aqueous solution, although with considerable hydrolysis. The free group is reduced by means of the alkali metals in liquid ammonia, very soluble salts $(CH_3)_2SnM_2$ being formed. The solutions of these salts possess an intense red color and are extremely reactive.

COMPOUNDS OF AMPHOTERIC GROUPS WITH STRONGLY ELECTROPOSITIVE ELEMENTS

Let us now return to the compounds formed between the alkali metals and univalent amphoteric groups. We have, here, a large number of compounds corresponding to the general formula $R_{n-1}A^nM$ where M is an alkali metal. Practically all the elements of the 6th, 5th, and 4th groups form compounds of this type. It is true, however, that only the derivatives of a few of these elements have thus far been studied systematically, or even, in some cases, recognized.

SALTS OF OXYGEN

The most common derivatives are those of oxygen, corresponding to the formula, MOR, where R is an organic group or hydrogen. The hydroxy bases belong to this class and, as is well known, are electrolytes in solution as well as in the fused state. While the alkali metal bases are very highly ionized, the bases of less electropositive elements are not as highly ionized as are their corresponding salts. Silver hydroxide, for example, is weakly ionized while silver nitrate is highly ionized. The inorganic bases are not ordinarily soluble in non-aqueous solvents so that it is not possible to compare their ionization in these solvents with that of ordinary salts in the same solvents.

Salts of the type MOR, in which R is an organic group, are extremely common. They include, in the first place, the alcoholates and phenolates, compounds which are closely related to the hydroxy bases. The alcoholates are known to be highly ionized when dissolved in the lower alcohols but we have no knowledge of their behavior in other solvents. The phenolates are highly ionized and many have been studied in aqueous solution. By introducing electronegative elements into the benzene ring, the phenols become comparatively strong acids and their salts can be studied in aqueous solution without the complications due to hydrolysis. It is not possible, however, to state whether the salts are more or less highly ionized as the corresponding acids are stronger or weaker.

The salts of carboxylic acids are likewise representatives of the groups that we are here discussing. Where the corresponding acids are sufficiently strong, so that hydrolysis does not obscure observations, these salts are all highly ionized in aqueous solution. Their ionization in non-aqueous solution appears to be much the same as that of ordinary salts where such solutions have been investigated. While the ionization of acids decreases rapidly as the negative ion becomes less electronegative, the same does not appear to be true of the corresponding salts, although the data are very incomplete.

SALTS OF NITROGEN

Nitrogen forms salts that are closely analogous to those of oxygen. The acid amides, in which an NH_2 group is coupled to a carboxyl group, have marked acidic properties in liquid ammonia and yield salts when treated with ammono bases. Some of these salts are relatively stable while others are readily hydrolyzed. So far as they have been investigated, these salts are highly ionized. The ionization of the ammono acids parallels that of the corresponding hydroxy acids although, usually, the ammono acids are weaker. Like the oxygen acids, the ammono acids become stronger as hydrogen atoms of the organic group are substituted by strongly electronegative elements or groups.

More interesting in some respects are compounds of the type R_2NM where R is an alkyl or aryl group or hydrogen. Corresponding to the formula H_2NM, we have the metal amides such as potassium amide, KNH_2, and sodium amide, $NaNH_2$. Franklin and Kraus (*12*) and Franklin (*13*) have measured the conductance of solutions of sodium amide and potassium amide in liquid ammonia solution. Both of these compounds are rather weak electrolytes, the ionization constant of sodium amide being 0.04×10^{-4}, and that of potassium amide 1.2×10^{-4}, as contrasted with a constant of approximately 25×10^{-4} for ordinary salts.

Hawes (*14*) has recently measured the conductance of solutions of sodium phenyl amide, sodium diphenyl amide, potassium diphenyl amide, and complex addition compounds of sodium and potassium amides with triphenyl borane, corresponding to the formula $MNH_2\cdot B(C_6H_5)_3$. The latter compounds are stable salts which are formed by the direct addition of triphenyl borane to the amides in liquid ammonia solution. The ionization values of these salts, together with those of sodium amide and potassium amide at 0.01 *N*, are given in Table I.

As may be seen from an inspection of Table I, the conductance of the amides is very greatly increased if a phenyl group is substituted for one or more of the hydrogen atoms. Thus, at a concentration of 0.01 *N*, the ionization of sodium amide is increased 10 times, on substitution of one of the hydrogen atoms by a phenyl group and, on substituting the second hydrogen

TABLE I

Ionization of Various Nitrogen Salts in Liquid Ammonia at −33.5°

Salt	*Ionization %*
$NaNH_2$	3.8
$NaNH{\cdot}C_6H_5$	39.1
$NaN(C_6H_5)_2$	54.3
$NaNH_2{\cdot}B(C_6H_5)_3$	62.5
KNH_2	11.8
$KN(C_6H_5)_2$	55.0
$KNH_2{\cdot}B(C_6H_5)_3$	65.0

atom, the ionization is increased 14 times. When the amide ion is coupled to triphenyl borane, the ionization is increased 16 times. Much the same thing is true of potassium amide except that potassium amide, itself, is more highly ionized than is sodium amide. It is evident that the ionization is increased not merely by substituting one or two of the hydrogen atoms of the amide ion by phenyl groups but also by coupling a large group, triphenyl borane, to the amide ion. The ionization of a salt MA^nR_{n-1} appears to be chiefly determined by the size and configuration of the substituent groups R.

That the negative ions of the above salts have a low affinity for the electron is evident from the fact that they are highly reactive toward oxidizing agents. All are immediately oxidized by molecular oxygen. In the case of similar compounds of elements of the 4th group, the energy of formation of the ions is only a few thousand calories (*15*).

SALTS OF ELEMENTS OF THE 4TH GROUP

The elements of the 4th group quite generally form compounds of the type MAR_3. In the case of carbon and germanium, salts of the type MAH_3 are known. Indeed, with carbon, we have the very extensive series of metal alkyls which possess marked salt-like properties and which conduct the electric current in solution—in zinc alkyls, for example. Sodium and potassium germanyl have been prepared. These are colorless solids which are readily soluble in liquid ammonia without ammonolysis and which conduct the current readily (*16*). Quantitative data, however, are lacking.

Organic derivatives of the type MAR_3 are well known in the case of tin, germanium, and carbon and, to some extent, silicon. Practically all the salts of this type are completely hydrolyzed by water. The alkali metal alkyls are generally hydrolyzed in basic solvents such as ammonia, but the alkali metal germanyls are not hydrolyzed in ammonia. The phenyl derivatives $MA(C_6H_5)_3$ are perhaps somewhat more stable toward hydrolysis than are the alkyl derivatives. The tendency to hydrolyze increases as we pass from tin to silicon.

The conductance of solutions of sodium triphenyl stannide, sodium triphenyl germanide, and sodium triphenyl methide has been measured

in liquid ammonia by W. H. Kahler (*17*). At corresponding concentrations, the ionization of the three salts is practically the same. The ionization of sodium triphenyl stannide at 0.01 *N* is 68.2 per cent. There is probably no other electrolyte that is so highly ionized in liquid ammonia unless it is the alkali metals themselves. In Table II are given the ionization values of various sodium salts including sodium bromate at a concentration of 0.01 *N*.

TABLE II

Comparison of Ionization of Different Sodium Salts in Liquid Ammonia at −33.5° and 0.01 *N*

Salt	*Ionization %*
$NaNH_2$	3.8
$NaNH{\cdot}C_6H_5$	39.1
$NaN(C_6H_5)_2$	54.5
$NaNH_2{\cdot}B(C_6H_5)_3$	62.5
$NaGe(C_6H_5)_3$	68.2
$NaBrO_3$	53.2

As an electrolyte, sodium diphenyl amide compares favorably with sodium bromate, the ionization values being 54.5 and 53.2, respectively. Sodium triphenyl stannide, as also the germanide and the methide, is unquestionably a much better electrolyte than the typical salt, sodium bromate. It is remarkable that the ionization of these salts should be so high and that, moreover, the ionization should be the same regardless of the central element to which the phenyl groups are attached.

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CARICATURES OF CHEMISTS AS CONTRIBUTIONS TO THE HISTORY OF CHEMISTRY*

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The art of caricature is very old, extensive, and amusing. For ages individuals who have displayed a conspicuous trait, experienced a particular episode, performed an unusual act, made an unexpected discovery, or committed an offensive blunder, in any field whatsoever, have been the subjects or victims of an artist with a humorous imagination and a facile pencil. Caricature ranges from the ludicrous to the vicious. In its normal expression caricature is "putting the face of a joke upon the body of a truth," though at times, especially during political, wartime, or social agitations, caricature loses its humor and becomes caustic, penetrating, convincing truth. Specimens of the latter type have great historical value, *e. g.*, the caricatures during the Napoleonic régime, the Disraeli ministry, the Roosevelt administration, and the World War.

FIGURE 1.—DR. BLACK LECTURING

Chemists have long been made the subjects of caricatures. In some instances the caricatures are gross, like the one by Gilray showing experiments with gases at the Royal Institution, or trivial, like the one in Punch which shows Father Thames presenting his business card to Faraday. Such caricatures have no historical value; indeed, they are thoroughly misleading and hardly worth one's study.

On the other hand there are some caricatures of chemists which are distinct contributions to the history of chemistry. They depict facts in the life of the chemist who is caricatured, and if we had only the caricatures themselves we could use them in constructing an accurate historical record. This article is limited to caricatures of the historical type.

As the first example we take Joseph Black, the Scotch chemist, who was professor of chemistry at the University of Edinburgh for thirty years. Figure 1 shows Black lecturing. This is one of the caricatures by John

* Read at the 80th meeting of the American Chemical Society, Cincinnati, Ohio, September 8 to 12, 1930.

Kay, a Scotch artist who made over 200 caricatures and sketches of well-known Scotsmen. The complacent countenance and the contemplative attitude, accentuated humorously by the wig, glasses, and gown, tell a definite story, *viz.*, Black was a deliberate lecturer. What are the facts? For thirty years Black delivered lectures on chemistry, illustrated by a few experiments. This was his method of teaching chemistry. The students performed no experiments, but took notes assiduously. The lectures were much the same year after year. They were handed down, and copies, by comparison with the lectures

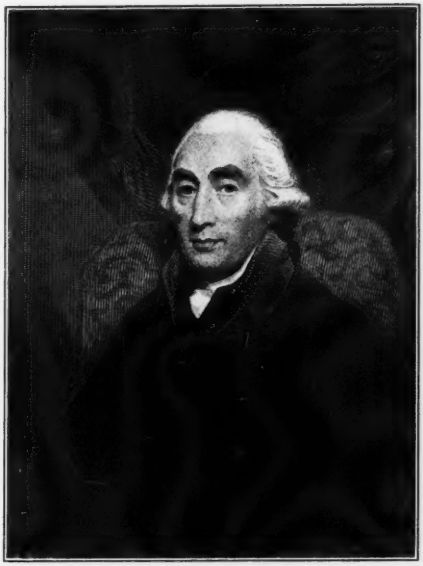
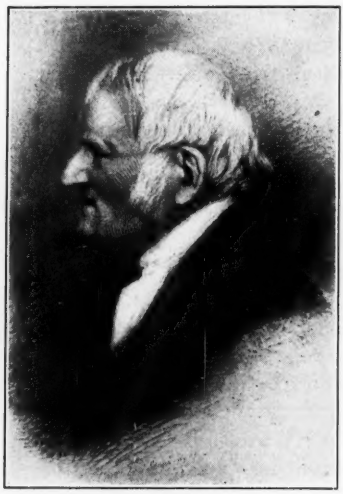


FIGURE 2.—JOSEPH BLACK

FIGURE 3.—JAMES HUTTON AND JOSEPH BLACK



FIGURES 4 AND 5.—JOHN DALTON AS CARICATURED AND PORTRAYED BY J. STEPHENSON

as published in 1803, show complete identity. In Figure 3—the Philosophers—we see Black and his lifelong friend, James Hutton, the geologist, apparently discussing some important subject. What are the facts? Nearly every day during a quarter of a century these two men met and calmly discussed matters of mutual interest, especially theories, new and old, in natural philosophy, *e. g.*, phlogiston, the rôle of oxygen, formation of the earth, proper diet, reforms in politics. These caricatures of Black were made in 1787. If we had only these two caricatures, without any account of Black, we could construct an accurate story of this chemist. concluding truthfully that he was a complacent lecturer and a real philosopher, methodical in habit, quiet in manner, precise in behavior, These characteristics are embodied in Raeburn's portrait of Joseph Black (Figure 2).

As the second example let us take John Dalton. Figure 4 is a caricature of Dalton which was drawn and etched by J. Stephenson. Dalton is obviously shown as an elderly man gazing thoughtfully at a modified wine glass half full of liquid. The Quaker costume is conspicuous. The goggles, still preserved, likewise cannot be missed. From this caricature we would assume that Dalton was a Quaker and a quiet, observant, reflective man. The facts of Dalton's life agree with our assumption. He was essentially reflective. There is no date on this caricature, but we have evidence that it was a little later than 1822. Figure 5 shows a portrait of Dalton drawn by J. Stephen-

son in 1822 which is obviously the original source of the caricature. However, if we had only the caricature, we could tell the general traits of Dalton and could visualize his appearance so faithfully preserved in the portrait itself.

For the third example we consider three caricatures of Joseph Priestley which are quite different from the friendly exaggerations of Black and Dalton. In Figure 6 we see a vicious caricature of Priestley, dated July 1, 1791. It was made by an artist who was afraid to sign his real name (the name in the corner, Norbal Scratch, is doubtless fictitious). Note the items in this caricature—the foot on a large book open at a page reading "Bible Explained Away," the left hand holding a smouldering manuscript labeled, "Essay on Government," the right hand holding aloft a burning paper labeled, "Political Sermon," the paper labeled, "Revolutionary Toasts," sticking out of his left coat pocket, while in the right pocket may be seen two papers labeled, "Essays on Matter and Gunpowder." Note also the comprehensive title of the caricature—DOCTOR PHLOGISTON, The PRIESTLEY politician or the Political Priest! What are the facts? In 1791 Priestley was driven out of Birmingham by the mob which sacked and burned his house and destroyed his apparatus,

FIGURE 6.—DR. PHLOGISTON, THE PRIESTLEY POLITICIAN OR THE POLITICAL PRIEST

FIGURE 7.—JOSEPH PRIESTLEY

FIGURE 8.—TALE OF A TUB

manuscripts, and books. Priestley had aroused the hatred of both church and king, and was regarded as a dangerous man—revolutionary in his ideas, seditious in his acts, and harmful in his books and tracts, to say nothing of his being a persistent, pestiferous disputant on all questions involving liberty in theology and politics. This caricature is a contribution to the history of chemistry. Had we only this caricature we could state the attitude toward Priestley and recount Priestley's struggles during the last three years he lived in England. Figure 7 shows a portrait of Priestley made at this time, and we can see that the caricature was thoroughly unfriendly. Figure 8 shows another caricature of Priestley made January 1,

FIGURE 9.—A BIRMINGHAM TOAST

1791. Note the large book labeled "Calculations," the tub inscribed, "Political Gunpowder," the sheets of paper headed, "Bind their king with chains," and the manuscript labeled, "Revolutionary Toasts," sticking from his pocket. Note also the sub-title, "Every Man Has His Price!" All these features are thoroughly vicious and hardly applicable to Priestley. He was not a violent man, but his foes were violent and continued their opposition for many years. A contemporary portrait shows that the artist had some basis for the caricature, especially the wig, though the face itself emphasizes the fact just stated that Priestley was not a violent man. The third caricature (Figure 9) is equally vicious. Priestley is shown plainly on the left, holding aloft an empty plate and from his lips are coming the words, "The ..... Head here." The omission is obviously the word "King's." The caricature with its caption, "A Birmingham Toast," implies bluntly that Priestley offered these words as a toast at the Birmingham meeting of the sympathizers with the French people. It is a fact, and was known at the time, that Priestley was not present at the meeting. Priestley to be

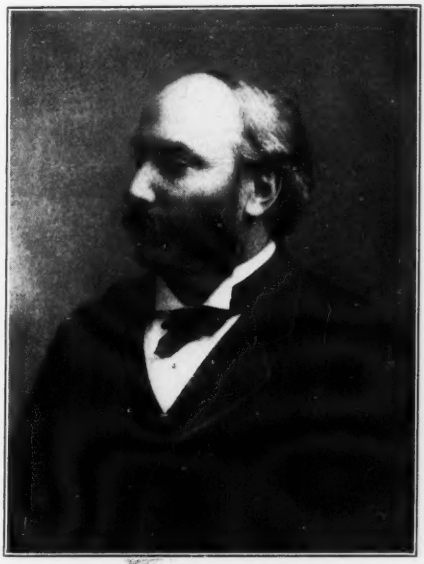


FIGURE 10.—LORD RAYLEIGH

FIGURE 11.—SIR WILLIAM RAMSAY

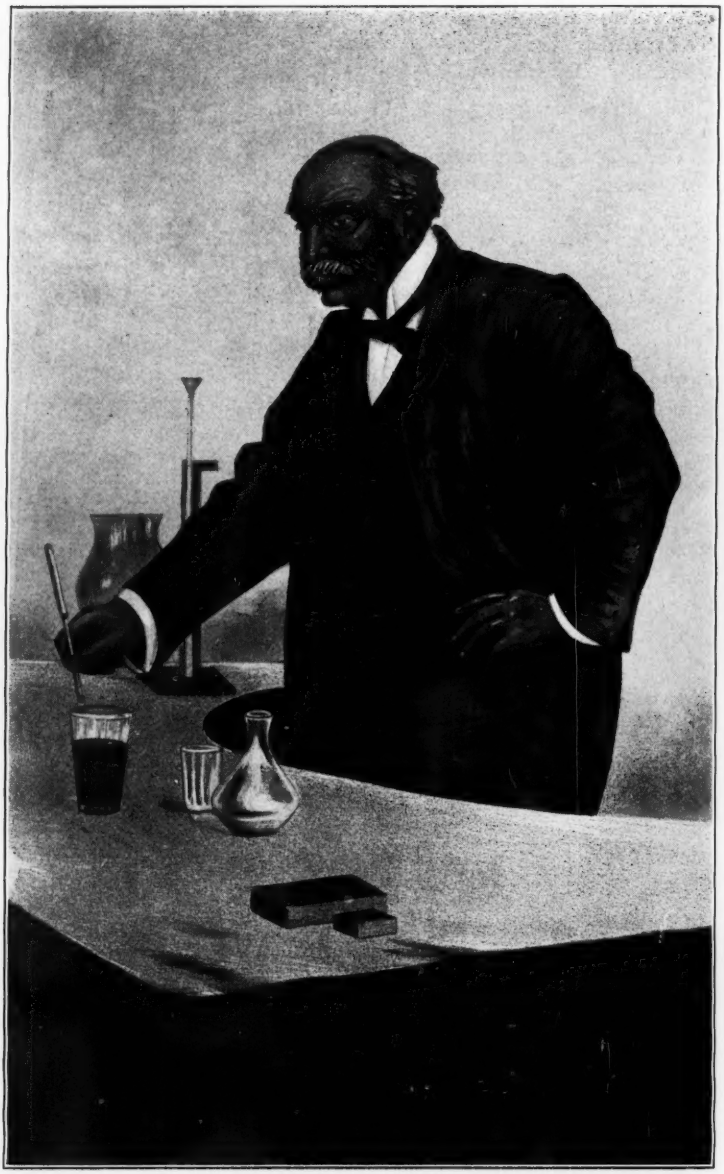


FIGURE 12.—"ARGON"

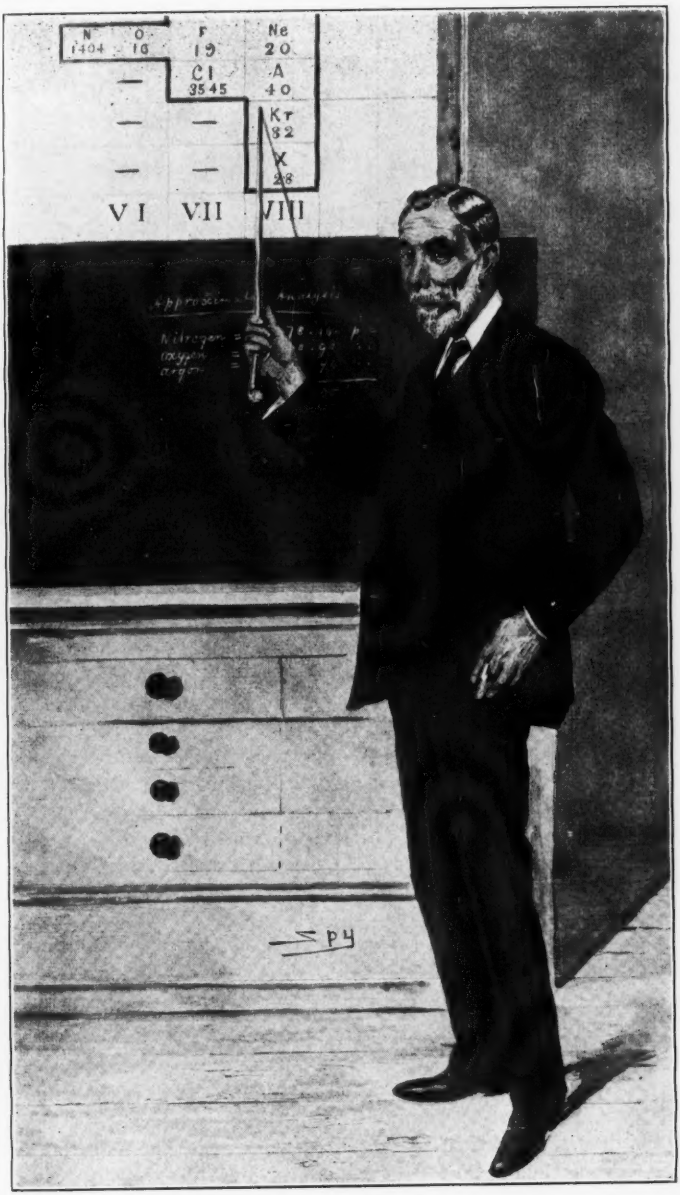


FIGURE 13.—"CHEMISTRY"

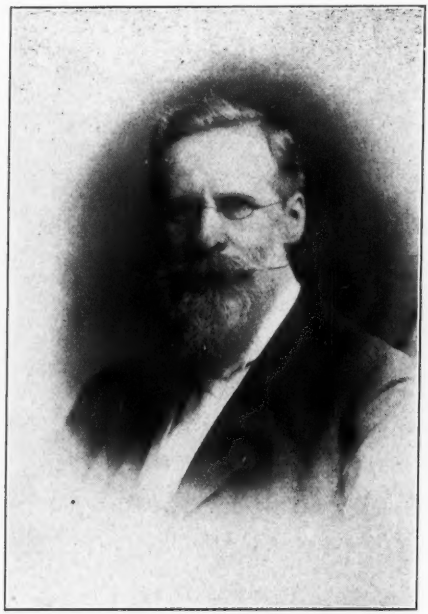


FIGURE 14.—SIR WILLIAM CROOKES

sure had at times expressed himself freely about the king versus the people, but he was too wise to state that political rights could be gained by decapitation of kings. This caricature is a typical example of the hatred and misrepresentation experienced by Priestley, and as such it is an historical item in the career of this chemist.

Let us take up quickly some more attractive examples, *viz.*, a few caricatures from the English magazine, *Vanity Fair*. The caricature of Lord Rayleigh shown in Figure 12 is typical of the *Vanity Fair* caricatures. It is entitled, "Argon," and was made soon after Rayleigh's work on the discordant densities of nitrogen gave Ramsay the clue to argon and its related gases. The caricature itself fixes the date of the discovery of argon, connects Rayleigh's name with the event, and is thus a contribution to the history of chemistry. The caricature is also a typical portrait-caricature, amusing, pleasing, humorous, and reveals the identity of the subject as we readily see by comparing the caricature with a photograph (Figure 10) of Rayleigh taken about the same time. In Figure 13 we have a *Vanity Fair* caricature of Sir William Ramsay. It was made by Sir Leslie Ward, who under the pseudonym of "Spy," drew caricatures for *Vanity Fair* for over forty years. This one of Ramsay was made soon after that of his co-discoverer, Rayleigh. The caricature of Ramsay is better than the one of Rayleigh because it is more humorous. Note the facial expression, the pose of the body, the thumb in his pocket, and the ever-present cigarette. The notation on the blackboard (which closely resembles the board in Ramsay's uninviting lecture room at University College, London) is drawn from fact, and the title, "Chemistry," is a sly, ironical thrust at Ramsay's somewhat comprehensive claims. As a caricature it is an excellent piece of work and is a contribution to the history of chemistry, fixing the approximate date of Ramsay's discoveries in the field of rare gases. Moreover, it is a pleasing, faithful

FIGURE 15.—"UBI CROOKES IBI LUX"

FIGURES 16 AND 17.—THE CURIES

portrayal of Ramsay, as we see from the photograph (taken about 1895) shown in Figure 11.

A much earlier caricature, also by "Spy," shows Sir William Crookes in a characteristic, though somewhat unconventional pose (Figure 15). His face discloses the great satisfaction he feels in holding a vacuum tube which he hoped would bear his name for years to come—a hope justified by events and enjoyed by Crookes. The title is exceptionally witty—*ubi Crookes ibi lux*. Here again, if we had only this caricature we could tell rather fully the story of Crookes and the Crookes tube. As a caricature it is a good example of the portrait type, as may be seen by comparing it with a photograph of Crookes taken about 1890 (Figure 14).

In Figure 18 we have a *Vanity Fair* caricature of M. and Mme. Curie drawn by "Imp." It is not so deft in touch or delicate in humor as the two caricatures by "Spy." There is too much emphasis on the personal appearance of both M. and Mme. Curie—especially the clothes and the head. Nevertheless the caricature is a contribution to history because it tells a touching story—the poverty of the discoverers of radium, their isolation, obscurity, personal sacrifice, and austere attitude toward life. It reveals also the complete absence of selfishness, pride, and avarice. Humility, not glory, is pictured on their faces, and the glowing tube—typifying radium—is held aloft for the glory of science, not of the Curies. Except for some satirical exaggerations of M. Curie, the caricature is a good example of the portrait-episode type, as may be seen by comparison with photographs of each taken a little earlier than the date of the caricature (Figures 16 and 17).

FIGURE 18.—"RADIUM"

FIGURE 19.—JACOBUS HENRICUS VAN'T HOFF

We next consider the van't Hoff caricatures. These are examples of the episode type. In Figure 19 we see van't Hoff as he looked just after middle age. Most of his life was spent in Amsterdam, Holland, where he labored day and night in stolid Dutch fashion. His fame outside of Holland came slowly but definitely. It culminated in 1896 when he was called to the University of Berlin and promised freedom from lectures and conferences. The call was a great temptation and he finally accepted. His acceptance brought forth many expressions of astonishment from his countrymen who could not understand why a Dutchman should want to leave Holland. Among these expressions was a set of rather striking caricatures. They were drawn by the Dutch caricaturist Braakensiek and published in a widely read weekly. They are in a series and represent van't Hoff making requests of a fish somewhat as children, and often "grown-ups", do in a fairy story. In the first caricature (Figure 20) van't Hoff says: "Fish, fish in the sea, bring me a cap and gown"—(*i. e.*, give me academic recognition). The fish replies: "Here it is." In the second one (Figure 21) van't Hoff, clad in his cap and gown, says: "Fish, fish in the sea, bring me a laboratory." The fish replies: "Here it is." In the third one (Figure 22) van't Hoff, clad in his cap and gown and emerging from the top of his laboratory, says: "Fish, fish in the sea, bring me an Order of the Crown"—(*i. e.*, an official, royal decoration). The fish replies (Figure 23): "Here it is." In the fourth one (Figure 24), van't Hoff, this time without cap and gown, not in sight of his laboratory, and apparently not wearing his royal decoration says: "Fish, fish in the sea.....?" but he does not complete his request because the fish replies: "Not yet enough? Adieu," and dives beneath the water, leaving van't Hoff in a doubtful pose on the bank. These caricatures tell us in a brief pictorial way exactly the opposite of what the caricaturist intended. Braakensiek would have the Dutch people believe, or perhaps

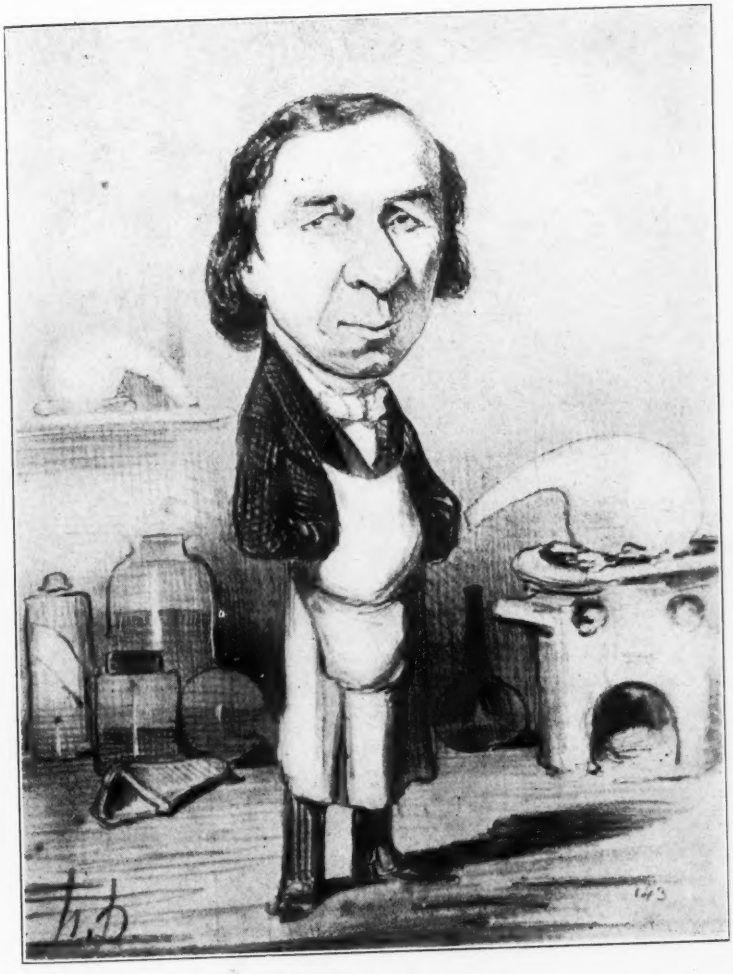


FIGURE 25.—DUMAS

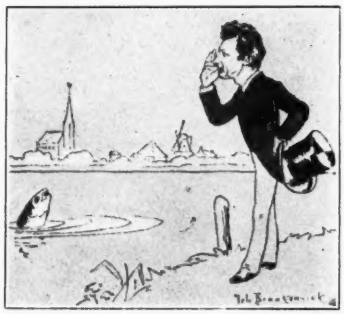


Figure 20

Figure 21

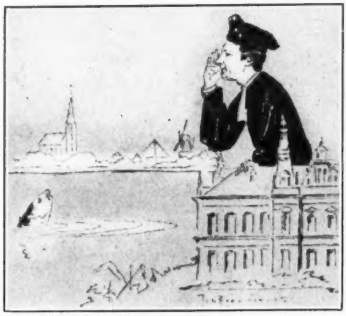


Figure 22

Figure 23

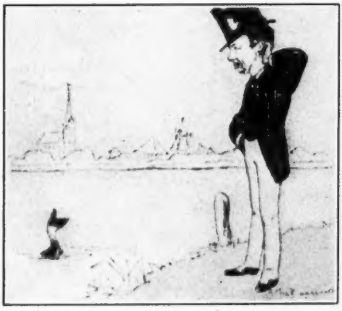


Figure 24

FIGURES 20 TO 24.—BRAAKENSIEK CARICATURES OF VAN'T HOFF

the people themselves did believe, that van't Hoff was an avaricious chemist, who periodically demanded favors; whereas, as a matter of fact, he had been overloaded with classroom work for years and actually had to use his fame outside of Holland as a lever to get the thrifty Dutch authorities to give him an opportunity to do research work under living conditions. As a series these caricatures, then, are a striking contribution to the history of chemistry.

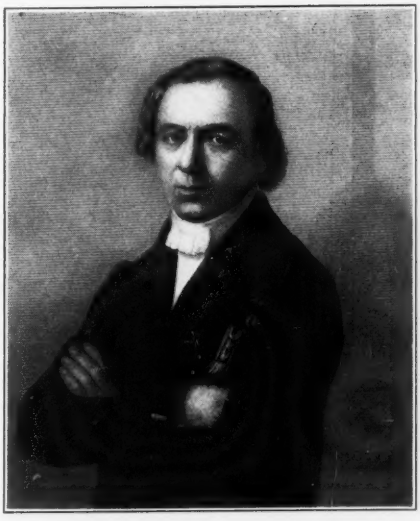


FIGURE 26.—PROFESSOR DUMAS

It is not generally known that Dumas was deeply interested in French politics. Up to 1848 he was so immersed in chemistry that he gave little time to other interests. But the revolution of 1848 compelled him to close his private laboratory and submit to a reduction of income. This personal loss was one of the reasons for yielding to the demand to share in the responsibility of administering the public affairs of his country. The caricature shown in Figure 25 was published May 4, 1850, shortly after Dumas entered public life. A portrait (Figure 26) made at this time shows that the artist was kind to his subject. The descriptive legend states in substance that the prodigy from the field of chemistry is able to do wonderful political things with his retort; in fact he does not come to the tribune to make his speeches since he spends his time analyzing the speeches of the other orators.

Dumas was elected first a member of the National Legislative Assembly; subsequently he became Minister of Agriculture and Commerce, a member of the Senate, and president of the Municipal Council of Paris. He continued in public life for about twenty years, *i. e.*, until the fall of the second empire terminated his political and administrative career. When Dumas was elected to his first public position he was about fifty years old and was a commanding figure in the chemical world. He was accustomed to choosing his own line of action. The caricature shown in Figure 25 is a contribution to the history of chemistry because it emphasizes the traits of Dumas, and if we had only this caricature as a guide we would conclude that Dumas was an independent, original, and self-confident chemist.

We come finally to Kekulé. In Figure 27 we see how he looked about

FIGURE 27.—AUGUST KEKULÉ

caricaturist, Carjat. In his monumental work on Kekulé, Anschütz records that Erlenmeyer senior told him the circumstances. "I was sitting in a beer garden with Carjat," said Erlenmeyer, "when Kekulé came up to us. Carjat said to me immediately, 'I must have that man.' Then," (said Erlenmeyer), "do not forget the fingers." This is an excellent example of a portrait-caricature. Note the impressive forehead, the voluminous whiskers, the general air of nicety. Note, too, the manuscript labeled "Chimie Organique". The coy lady in the background, holding a burning heart, I am at a loss to interpret. All in all the caricature is a

1860. In this year Kekulé was a delegate from the University of Ghent, Belgium, to the Karlsruhe Congress, being at this time an ardent and impressive expositor of the theoretical aspects of organic chemistry. When this Congress broke up after a series of fruitless sessions, Kekulé, like most of the delegates, departed quickly for a delayed vacation. He went first of all to his beloved Heidelberg, where he had spent two years (1856–58) as a sort of privileged *privatdocent* before he was called to Ghent (in 1858). It was here in a Heidelberg beer garden that the famous caricature of Kekulé (Figure 28) was made by the German

FIGURE 28.—KEKULÉ AS CARICATURED BY CARJAT

contribution to the history of chemistry, for if we had it alone we could truthfully conclude that Kekulé as early as 1860 was regarded as an able organic chemist.

Other examples of caricatures might be cited, but those shown in this article suffice to prove the thesis that caricatures of chemists are often contributions to the history of chemistry.

Small Dose of Drug Makes People Tell Their Secrets. A psychologist has discovered a means of "breaking the ice" which will make even the most reserved person anxious to discuss his private affairs. It is a small dose of sodium amytal, a derivative of barbituric acid related to the common drugs veronal and luminal, which has been used for years as an anesthetic.

Dr. Erich Lindemann, of the Psychopathic Hospital of the State University of Iowa, told of its new use at the meeting of the American Psychological Association at Toronto recently. His research on the psychological effects of sodium amytal was begun as a result of the effective use of this drug in the treatment of certain mental diseases. Its use in psychiatry was to produce a deep sleep. Physicians also noted that this sleep was followed in the case of depressed or excited patients with a period of calm and contentment. Some stuporous patients were given lucid intervals.

In the psychological laboratory of the Psychopathic Hospital, Dr. Lindemann performed the experiment of giving a very small dose of this same drug to psychotic patients in the hospital and also to normal individuals. This dose, though too small to produce anesthesia or even sleepiness, had a decided effect on the emotions and on the subject's personal relations with those about him.

The most striking effect on the normal subjects was the desire to tell about personal matters which the individual would ordinarily want to keep hidden. Under the influence of this drug, a person is unable to refuse to answer questions about the most intimate matters. He shows a warm emotional attitude toward others, and has a feeling of strength, self-confidence, and serene contentment.

Dr. Lindemann suggested that this drug would be of great importance to the physician who must learn the secrets of diseased minds in order to give effective treatment.—*Science Service*

Forgetting Not Caused by Disuse. When the stenographer blames lack of dictation for her loss of memory of shorthand, she is laying the trouble to only a minor factor in her forgetting, we may assume from a recent psychological study of forgetting reported to the meeting of the American Psychological Association at Toronto recently.

Forgetting is not primarily due to disuse, but to the experiences that occur during the period of disuse, Dr. John A. McGeoch, of the University of Missouri, told the psychologists.

"Disuse is significant only in that it gives other factors a chance to operate," Dr. McGeoch said. The experiences which follow the learning may have a backward-acting effect in inhibiting memory.

"Other factors, such as the method of learning, the age of the subject, the character of the material, and disuse itself, may set limits to the operation of the primary factors, but are themselves secondary in importance."

Forgetting is not just the opposite of remembering, but must be studied as an entirely different problem, Dr. McGeoch believes.—*Science Service*

THE PHYSICS AND CHEMISTRY OF SURFACES*

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When an insoluble substance, whose molecules possess a greater attraction for water than for other molecules of the substance itself, is placed on a clean water surface, it spreads out into a surface film. The film so formed will be one molecule thick, for when every molecule reaches contact with the water the affinities of the molecules will be better satisfied than in any other way. Substances which form monomolecular surface films with ease are those which have water-soluble groups such as COOH, NH_2, etc. The polar head of a long-chain paraffin molecule having such a group at one end tends to bury itself deeply in the water while the rest of the molecule stands steeply oriented to the surface, since long paraffin chains resist immersion. The formation of a stable, monomolecular surface film may be regarded as the solution of the polar end-group of a molecule in the water, the rest refusing to be dragged in.

Langmuir obtained force-area curves in which the two-dimensional pressure of a surface film against a floating barrier is plotted against the area per molecule in square Ångstrom units. Such curves were found to be exactly analogous to the pressure-volume curves of three-dimensional systems. With the aid of the Langmuir apparatus it has been possible to demonstrate the existence of two-dimensional films in the solid, smectic, liquid, and vaporous states, to observe the phenomenon of two-dimensional dimorphism, to study the conditions of phase equilibria and to measure the entropy changes associated with the process of two-dimensional fusion, vaporization, and sublimation. There is thus a complete thermodynamics of two-dimensional films entirely analogous to the thermodynamics of three-dimensional systems.

The rigidity of solid films may be demonstrated by scattering talc upon the film and then blowing upon the film. There is a discrepancy between the measurements of the cross-sectional areas of the hydrocarbon chain as measured by the film method and by means of X-rays which suggests that the long chains of fatty acids adhere to one another in solid surface films in such a way that the zig-zags of the chains interlock, for then the mutual potential energy is at a minimum. When the area per molecule obtained from a force-area curve is corrected for the tilt resulting from such interlocking, it agrees exactly with the cross-sectional area per molecule derived from the X-ray analysis of crystals of fatty acids. In the case of the solid film of palmitic acid, the area per molecule extrapolated to zero compression is 20.6 square Ångstrom units.

Evidence has been obtained to show that the molecules in gaseous films lie flat on the surface. Kinetic theory shows that the equation of state of an ideal gaseous film is $FA = RT$ where F is the two-dimensional pressure and

* Dohme lecture delivered at The Johns Hopkins University, October 20, 1930, as reported from notes taken by Willard E. Bleick.

A the area of the film, R and T having their usual significance. This is analogous to the equation of state $PV = RT$ of an ideal three-dimensional gas. When FA is plotted against F for an actual gaseous film, curves of deviation from the perfect gaseous state are obtained which are of the same form as those obtained by Amagat who plotted PV against P for actual three-dimensional gases.

Dr. Rideal next described a method of investigating the architecture of surface films which has been developed into a method of precision by himself and his collaborator J. H. Schulman. It has long been known that interphasic potentials which are not of inconsiderable magnitude exist between air and liquid. The present method consists in measuring the potential difference between a platinum wire situated above the surface of a glass Langmuir trough and a calomel electrode establishing contact with the liquid in the trough. The trough is placed on insulated stands in a well-earthed Faraday cage. Above the trough is suspended from a sulfur-insulated drawbridge a platinum wire upon which a small quantity of polonium is electrodeposited. Connection between the platinum wire and the needle of a Lindemann electrometer placed on an insulated bracket inside the Faraday cage is made by means of a magnetically operated switch. With a plate voltage of 70 volts the potential difference between the air electrode and the calomel can be measured to ± 2 millivolts, using the Lindemann electrometer as a null instrument, the movement of the fiber being observed through a periscope placed above the Faraday cage. The whole apparatus was mounted on brick pillars in a small cellar maintained at constant temperature.

With this apparatus it is found that reproducible air-liquid potential differences could be obtained, independent within relatively wide limits of variation of the height of the polonium-coated wire above the surface of the liquid, usually N/100 HCl in the trough. The calomel electrode, to eliminate liquid junction potentials, was filled with the same electrolyte as was present in the trough. Solutions of palmitic and myristic acids in freshly distilled petrol ether served as stock solutions of film-forming materials. In carrying out an experiment the surface of the electrolyte in the trough was scraped with a waxed glass slide in the usual manner in conducting experiments with a Langmuir trough, the drawbridge holding the "air electrode" was lowered into position by means of a silk string and the interphase potential difference was measured with the aid of a Wheatstone bridge and the Lindemann electrometer. If the surface of the liquid be clean, repetition of the operations of scraping and measurement yield the same value for the potential difference.

A film is now spread on the surface of the liquid and after evaporation of the petrol ether the interphase potential is again determined. The film can be expanded or compressed by means of a waxed barrier in a manner

identical with that employed by Langmuir and the change in the interphase potential simultaneously determined. When the change in interphase potential, ΔV, caused by the presence of the films of palmitic and myristic acid, is plotted as a function of the molecular area, a curve is obtained having pronounced breaks which correspond exactly to the breaks in the force-area curves for films of these acids. Inspection of the arrest points of the curves and a comparison with those obtained in a Langmuir trough reveal the fact that over periods of phase transitions, expanded to liquid condensed, and expanded to the vapor state, the interphase potential remains constant. Since in the first case the number of molecules per sq. cm. is increasing and in the second decreasing as the phase change progresses, it necessarily follows that the molecular contribution of the fatty acid film to the interphase potential must change with the state of the film. Although the distributions of the electric field in a terminal carboxyl group immersed in the water are at present unknown, we may regard their composite effects, as contributing a component of electric moment, p, vertical to the water surface. If the number of molecules, each contributing a component of electric moment, p, be n per sq. cm., we obtain from the Helmholtz equation, $\Delta V = 4\pi np$, the mean electric moment, p, from the observed values of ΔV and n. When these values of electric moment of myristic acid are compared with the state of the film as derived from the force-area curve we note that the electric moment in the expanded phase is constant and equal to 2.36×10^{-19} E. S. U. In the liquid condensed phase at zero compression it is equal to 1.46×10^{-19} E. S. U., while at the moment before the molecule assumes the horizontal position of the vaporous state, where the moment becomes very small, it possesses the large value of 3.7×10^{-19} E. S. U.

It is also noted that part of the transition from vapor to liquid or expanded and the complete transition of the liquid or expanded to the liquid condensed form takes place with a regular change in the mean moment, *i. e.*, the molecules of each phase can exert their own characteristic molecular moment when two phases are present. The variation in the electric moment with compression over the region vapor, liquid expanded, and liquid condensed forms is compatible with the view that the change in the moment is due to a progressive tilt in the molecule. Only on compression of the solid condensed phase does there appear to be any considerable mutual interaction of the head groups.

Dr. Rideal concluded by describing recent attempts to investigate by this method the nature of films of iodine on a mercury surface and of films of alcohol on solid metallic surfaces. It has been shown that when a crystal of iodine is placed on a mercury surface, spreading occurs to form a monomolecular film until a definite equilibrium spreading pressure is reached. This pressure is a direct measure of the attraction of the iodine molecule for the mercury surface.

THE CHEMICAL EXPERT*

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Experts are not necessarily all liars, any more than all liars are experts. The most dangerous thing a reputable expert can do is even to consider lying, for he thus begins digging a pit for his own downfall. The worst possible qualification is skilful lying, for skill involves practice and practice involves habit. The judges recognize the tendency, and lawyers learn that this particular expert is not convincing. The psychology of convincing testimony rests on integrity in the strictest sense. The next most important qualification is steady self-control and self-discipline. Then come physical condition, clear, accurate, and fearless thinking, and painstaking cultivation of certain mental habits and accomplishments. Education is defined in this sense.

. . . . . .

It is no figure of speech to call myself still a student. Month after month, year after year, it is my privilege to sit at the feet of those who really know the sciences and the arts and to learn, so far as I am able, all that they can teach me of some special phase of their work. And so let me say that in this meeting we have both been deceived. You expect to hear some one who knows tell what an expert really is, while I *did* expect a most pleasant and informal chat at Rutgers with a small group of fellow students. Both of us were wrong.

If asked to speak publicly upon this subject, I would certainly have refused on two grounds; not being in any sense an authority on the subject, and being very loath to say at any public meeting what might be thought to be critical of any other man's work in court.

The change in program does create a bit of a situation which was nobody's fault and cannot now be helped, which must be met, and for which your indulgence is asked. You see, there are some other old fellows of about my own vintage in the audience. It might be unwise to talk of what the expert witness is. If pleasant things were said these old cynics might smile and think, "He's talking about himself." If unpleasant things were said he might be "talking about his opponents."

Fortunately there is yet something that can safely be discussed. Though it may be unwise to talk of what an expert *is*, it should be safe to talk of what he *ought to be*. Those experts who happen to hear will hear themselves truly enough described to recognize and approve of the general portrait in spite of minor errors.

There is a real reason why the ideal picture should be presented to youth—a better picture than any example can supply. Man may achieve beyond his hopes, but not beyond his ideal. Youth, with its virility, its enthusiasm, and its career yet to plan, is entitled to a better picture, more

* Delivered before the Students' Course in Industrial Chemistry held at the 13th Exposition of Chemical Industries, New York City, May, 1931.

ideal both in its demands and its rewards; else there can be little of that hope which makes life worth living, the hope that our sons and our pupils may do better than we have been able to do.

There is no more debasing excuse than "lots of others do it"; no more sure degeneration than to aim at the average standard of achievement. That is far below the capacity of almost any man who will try to do his best. Arrows do not fly higher than they are pointed.

The qualities which an expert should have depend upon what is meant by expert; on a definition, built up of words, and words are but inaccurate symbols of ideas. Clear, accurate thinking deals with ideas and concepts rather than mere words, for words are dual or multiple in character. They shade their meaning as the chameleon does its color; with origin, time, and position. Back in the last century when I learned the words, "O, yes," they had but one meaning. Look at the poor things today. "O, yeah!" in refusing a loan, or "O, yeah?" in comment on some miracle.

So it is no surprise to find the expert variously defined. For example, we have "Liars, damn liars, and experts," or "One skilled in the art of answering all his lawyer's questions, and evading all the opponent's questions without appearing to do so." Perhaps the classic is the definition of the expert relay. It is said that in the archives of the Patent Office there is an application which describes a weird form of telegraphic relay. The inventor knew little of electricity and less of mechanics. He thought that the longer the moving bar, the more sensitive would be the relay, and that if the bar were vertically pivoted to swing horizontally, the damping effect of gravity might be overcome. The Examiner found nothing like it, so he wrote the applicant that the device appeared to be novel and that the claims properly distinguished it from the previous art but, before passing the case to issue, he would like to know why it was entitled "Expert Relay." The answer was, "It is called a relay because it is an instrument for relaying forward telegraphic messages, and it is called an expert relay because it has a long tongue, suspended in the middle and adapted to lie with equal facility in either direction according to the nature of the influence brought to bear."

Yet stop a moment. How often in history has the man who knew more than his fellows, or who understood things better, been called a liar, magician, or lunatic. It may be that all experts are not liars any more than all liars are experts. A court expert is one whose training and experience qualify him to advise the judge or jury concerning matters which are beyond the average ken of ordinary mortals.

The question at issue may concern the past. As a chemical instance, what did alum mean to an inventor writing in England in 1893—soda or potash? A whole book has been written on that general subject. Again, how does it happen that a U. S. inventor in 1888 writes in all seriousness that

he dissolved gun cotton in ether? Nitrocellulose is not soluble in ether. The expert is supposed to know (or find out) that U. S. P. ether of that date contained about 21% of alcohol and was a perfectly good solvent.

Or the particular issues in a given case may determine the answer. When is a substance which is highly soluble an insoluble agent? This sounds like a conundrum, but a moment's thought will tell you that when the only part of the substance which functions for the purpose in hand is the part which is not dissolved, and it functions for that reason only, then it becomes an insoluble agent when it is present in excess of its solubility. What is oleic acid? It may be a fat in the lubricating art because it is used as a fat is used, to make soaps in compounding grease, or it may be a corrosive acid on brass bearings if present in excess; whereas, in the art of duplicating stencils it may be an oil replacing castor oil as a tempering agent for nitrocellulose; or again it may function as a fat when it is used to make the stencil more friable. Before he testifies the expert is supposed to know, and to know why. Time was when the expression of the expert's mere opinion carried great weight. Perhaps it does today, but no man's opinion carries half as much weight with you as your own opinion, provided you are given conclusive reasons why that opinion is correct. Judges and jurors are just human beings.

When carefully considered, many apparently absurd statements not only become reasonable, but they become in fact the only valid proof with respect to the particular issues in the particular case. In my humble opinion, the worst qualification a court expert can have is to be a skilful liar, for skill requires practice and that creates habit. The expert who even *considers* lying out of a tight place begins to dig a pit for his ultimate downfall. He is conditioning his mental reactions to seek the easy way that some time will lead into a fatal trap. Expert work is like tight-rope walking over Niagara Falls. A man makes just one serious mistake. Nobody who views the remains may know, and few will care, whether the fall was deliberate, cowardly, or just accidental. The effects are pretty sure to be fatal professionally and not unlikely to be so literally. In my short experience, I think I have seen two men go that way and it is a pitiful sight. A man may be so shrewd, quick-witted, and experienced as not to be caught outright, but judges too are shrewd men with highly trained perceptions. They may first admire, then question, but finally draw their own conclusions. Soon the lawyers question the value of such a witness to their cases.

In the eyes of the law, an expert witness is generally a member of one of the learned professions who, because of his professional character and special knowledge, is assumed to be friendly to law and justice; to be a "friend of the court" and able to advise the court and/or the jury wisely and honestly. As a friend of the court, he is accorded a certain distinction and certain privileges. He can refuse to answer a question with "Yes" or "No" if it is

ambiguous. He can refuse to answer a question without qualification or explanation. He can express opinions. He can even state technical facts beyond his personal experience and knowledge. To the right-minded man every privilege brings its corresponding obligation. What manner of man should such an expert be?

For his own good and that of society, for the sake of that respect for law and justice on which civilized society depends, he should have one outstanding qualification—integrity. Not merely in the colloquial sense that he pays his collectable debts and has not yet been caught lying or stealing, but in its phylological sense of at-one-ness, in the sense that he is a unified personality, without dual or multiple habits of life or thought. He should thus be free from the fears, uncertainties, or hesitations that indicate a schizoid personality of any kind. Thus only can he react automatically, instantly, and naturally to any sudden stimulus, in harmony with himself and with his situation. He will tell the truth as well as he knows it because he is true, and guide the court or jury as best his mentality, training, and experience permit. When he appears in a case, rest assured that he believes his client has a just right to win, and that he sees an honest way to win, no matter how hard or long. Such a man will meet your eye squarely, yet without effort. He will admit a mistake naturally, yet without dodging. He will be grateful when his attention is called to an error. He will deny nothing which he has said and though he may change his mind, the change will clearly be made because he wants to make it in the interest of accuracy.

Probably no man has wholly escaped the scars of living; the tender spots where he has been bruised and torn in the struggle, the mental conditioning to fear, the hesitation which of his two or more selves shall act at a given instant. But the more nearly he is free from these, the more candid, sincere, and likely to be correct will be his testimony—certainly the more impressive and convincing it will be.

The next most essential quality for the ideal expert is a masterful will directed to self-domination. This does not mean that the man is domineering, or even stubborn—quite the contrary. It means that he has the steady purposeful self-control by which alone he can hope to do all the things he has to do in the way of self-direction and development. Some of these things may be lightly touched upon.

One is the cultivation of a sound, lithe, well-coördinated body—the finest that his physical inheritance permits. Modern psychology is teaching us that such training of the body also helps greatly to train the mind. Experience and common sense teach us that physical health, stamina, and virility are essential to long hours of driving, concentrated work. Court work is like catching a train: the hardest kind of running *after* it has left is useless. It is no mean test of a man's reserve power to work 36 out of each successive 48 hours for 6 weeks, in the preparation of a case and still be fit to go on

the stand. It may be necessary to work all day and all night before going on the stand for direct examination and cross examination at the opening of the case, work straight through the next night in developing further proof of matters in question, go on the stand perhaps all the next day under cross, and be alert, clear, and forceful up to the end of that 50 hours.

Then comes the training of his own emotions into the most perfect possible subordination to his mind. Otherwise they may becloud his own judgment and reasoning, or else may interfere with his generous understanding of the other fellow, his virtues and strength as well as his shortcomings and weaknesses. It is equally dangerous to overestimate an assistant, or to underestimate an opponent.

He should train himself to the unconscious practical application of psychology for controlling and directing himself with the least strain and lost energy, as well as for the understanding and appraisal of others with the least delay or prejudice, and also for the guidance of others in physical and mental operations with the least friction and opposition. Perhaps most difficult of all, he should train his ability to do any and all these things until he can do them unconsciously, so that they appear wholly natural because they have become so, and do not interfere with his own quick, clear, accurate thinking about the things on which he is consciously intent.

Another is the cultivation of the habit of precise, direct, and fearless thinking without dodging or straying. What a task, all by itself! Yet how essential it is for one who is to guide others in their thinking, on which wealth, happiness, and perhaps life may depend.

There is also the training of the mind to simplicity of viewpoint and reasoning, because the expert's thinking is almost useless unless it can be expressed in speech, preferably in short sentences of well-known words, accurately applied, and connected by a logic which is at once so accurate as to be unquestionable and so clear as to be almost obvious. Common sense appeals to the hearer immediately it is uttered—it is so rare and simple.

Among the incidental accomplishments of great value to the expert is the habit of speed writing for taking his own notes on testimony, for use in prompting cross-examination by counsel. Another is skill in lip reading, to understand what is being said too softly for accurate hearing, or said by a witness in a noisy courtroom, or by others generally when the expert himself has become invaluable for his age, experience, and ripe judgment but is getting old and deaf. A third is the possession of a quiet, well-modulated voice, of great carrying power and yet of pleasant timbre with an enunciation that is Parisian in its precision and clarity, in order that what he says may be clearly heard and instantly and accurately understood and recorded.

Is that enough to ask one man to do? More than enough. But you young men have a twenty-years' handicap to help you in the race for success such as I may never hope to achieve—far greater than I can hope even to

approach. I was over forty before accident first put me on the stand as an expert. But it is a great life if you don't weaken, a joyous process of learning something every day. There are probably few men from whom the wisest cannot learn something. One should avoid becoming too old or too self-satisfied to learn. When one ceases to be able to learn with pleasure, that measures the real span of life. After that he begins to die.

You have, perhaps, been expecting to hear what particular branch of science to study for this type of work. I do not know that it makes much difference. You cannot get along without chemistry and physics because they underlie all other sciences and either without the other is a very lame steed. It is not so much a question of what you study, as how you study. When I was going off to boarding school, father asked me why. I said, "to learn." He shook his head. After leaving me in doubt long enough to impress the answer on my mind, he said: "No, son, you are not going to school to learn in any sense in which you understand it—not to learn what is in the books or what your professors may be able to tell you, but to educate yourself. The learning is purely an incidental means to that end. What you learn will be in the books and you will be able to look it up when you want it. If you get an education you will be able to pay somebody to look it up for you. If you ever get really educated, you will be able to pay somebody to stand around at your elbow and know it for you. Half of it is wrong anyway. What you are going to school for—and I hope to college, if you are worth while—is to get acquainted with your mental tools, to form the habit of keeping them clean and sharp and well arranged so that you can put your finger on them when you want them, and to acquire by grueling experience facility in using those tools with force and precision and despatch on any material that you want to, in any direction that you want to, as long as you want to, and then to stop."

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THE PURPOSE AND PLAN OF THE INSTITUTE OF AMERICAN MEAT PACKERS*

C. Robert Moulton, Institute of American Meat Packers, Chicago, Illinois

The Institute of American Meat Packers is the trade, educational, and research association of the meat-packing industry established in 1919 to look after the general welfare of the industry, to promote proper trade relations, to prosecute research into the products and problems of the industry, and to inform the public about it. It functions through more than forty standing committees, three commissions, and a staff of ten departments. These departments are: Live Stock, Packinghouse Practice and Research, Purchasing Practice, Marketing, Waste Elimination, Nutrition, Public Relations and Trade, Scientific Research, and Industrial Education. Through the Commission on Elimination of Waste, Commission on Inspection, and the Institute Plan Commission the special functions indicated are prosecuted. The last-named commission deals with the educational work of the Institute.

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The Institute of American Meat Packers is the trade, educational, and research association of the American meat-packing industry. It represents a very large percentage of the total commercial production of meat in the United States and in addition it has members in Canada, the United Kingdom, Australia, and New Zealand. Small operators as well as the largest are included in the membership.

In its present form the Institute was established in 1919 as an outgrowth of the American Meat Packers' Association which had been founded in 1906. The purposes of the organization are stated in a general way in the opening sentence of this article. More specifically the Institute aims to secure cooperation in lawfully and properly looking after the general welfare of the industry, to afford a means of presenting to state and federal agencies the needs of the industry, to foster trade at home and abroad, to promote the mutual improvement of its members and to study the arts and sciences pertaining to the industry, to acquaint the public with the place and economic worth of the industry, and to encourage coöperation with the livestock producers and the distributors of meat-food products in matters of mutual interest.

As a means of accomplishing these objects the Institute makes use of more than forty standing and special committees and three commissions. The staff consists of ten departments as well as branch offices in New York and Washington. Each department is headed by a director and some departments have two, three, or more additional members. The committees are composed of experts from various member packing companies and the commissions are recruited from the same source. Each department di-

* This is the first of two articles on the purposes and activities of the Institute of American Meat Packers.

rector is an expert in his line who devotes his full time to the work of the Institute. This makes possible proper coördination of staff and industry, of theory and practice, and of research and operation. This, of course, does not mean that staff members are not thoroughly conversant with practical conditions in the industry. It simply recognizes that the industry possesses a wealth of experience which is invaluable to the work of the various departments, no matter how well prepared the directors may be.

The foregoing outline indicates adequately the scope of the activities of the Institute and also furnishes a brief outline of the methods employed in obtaining results. Such an institution did not spring full-grown from the plan of organization adopted in 1919. Rather was it the result of slow growth built upon a carefully worked out plan and nurtured by the willing administrations of the committee members and the executive officers of the Institute.

The first functions to be added to those of the original trade association were the functions of research and education. Under a vice president in charge, bureaus of public relations, home economics, and nutrition were established to gather all existing information pertinent to those fields and applicable to the meat-packing industry. This information was used to inform the membership and the public concerning the functioning of the industry, the value of its products as foods and methods of preparing them for use in the home and in institutions catering to the public.

As an especial aid to the furthering of the aims of research and education as well as a means of separate financing during the period of formation and acceptance, there was formed an Institute Plan Commission under which departments of scientific research, packinghouse operation and research, and industrial education were soon functioning.

As the plan developed and became fully effective, experience indicated that some changes in the departments might be made. Some departments were discontinued, such as those of home economics and traffic, while others were added. The present staff organization includes the following departments: Industrial Education, Live Stock, Marketing, Nutrition, Organization and Accounting, Packinghouse Practice and Research, Public Relations and Trade, Purchasing Practice, Waste Elimination, and Scientific Research.

Departmental Activities

The Department of Live Stock seeks to conserve and improve the supply of livestock. It works among livestock producers, transportation agencies, packers, and others to reduce losses incurred in bringing live stock from the farm to the packing plant. Proper equipment and proper handling have been shown to pay in the better quality and quantity of the utilizable finished product which the packer makes from livestock so handled. In

addition this department tries to help develop types of animals that more nearly meet the demands of the consumer. There has been and continues to be a definite trend toward smaller steaks and roasts from the beef animal on the part of the purchaser. Likewise a handier hog carcass yielding less fat and more ham, bacon, and chops is in greater demand. Then there is the problem of so utilizing certain feeds such as soybeans and peanuts that hogs fed upon them will produce a carcass that is not too soft for trade demands. In the solution of all these problems this department attempts to offer a helping hand.

The Department of Packinghouse Practice and Research offers to those companies desiring it counsel and aid in solving operating problems. It investigates new ideas, methods, and machines; collects the experience of the industry on such matters as coal costs and the cost of packing sliced bacon; conducts an accident and fire-prevention program; and carries on a comprehensive standardization program which has resulted in a material reduction in the number of the sizes and styles of pieces of equipment and various containers used. The giving of advice on various operating problems to individual companies is one of the most valuable of the services rendered by this department. Needless to say the director is a man of much experience in packing-house operations. He has also the advantage of consultation with the committees qualified in his field and frequently consults with other department directors so that the knowledge and experience of many individuals may be made to focus on a given problem.

The Department of Purchasing Practice collects cost information on supplies and articles of equipment and enables member companies to obtain prices in many instances which are lower than a single company can obtain. Some companies save more than the amount of their dues by making use of this department. Frequently other expert knowledge is required before the department will decide to issue information concerning costs and use of certain articles. The knowledge of other staff officers and the facilities of the laboratories can thus be called upon. In this way, individual companies in particular and the industry in general are saved from needless exploitation.

The Department of Accounting has conducted cost studies which have developed information of great value to the meat packer. The booklets on accounting methods prepared by it have met with widespread approval.

The Department of Marketing is one of the more recently organized Departments, but it has already developed much useful information concerning the marketing of packinghouse products. This is issued regularly to members in the form of a bi-weekly report on storage stocks and a weekly report on livestock slaughter and cutting margins on hogs. Similar material on beef is being developed.

The function of the Department of Waste Elimination is to get rid of waste wherever it can be found. Excessive delivery service in various communities and similar wasteful practices have been eliminated. Efficiency and economy are thereby promoted.

The Department of Nutrition develops information on the food value of meat, circulates this information through booklets and articles to physicians, dietitians, nutrition specialists, and others, and defends the packers' product against the unfair attacks of faddists, misinformed persons, and others. As a result of the defensive work of this department and the Department of Public Relations and Trade, advertisements adverse to meat, which formerly reached millions of consumers, have practically disappeared. Since the director of the Department is acquainted with the field of animal nutrition he assists the Department of Live Stock in some of its activities. The Department of Nutrition also aids in developing information by means of research in the fields of human and animal nutrition. This aid has usually taken the form of research grants to individuals in universities or in research institutions preëminently equipped and staffed to do the work required. Some of the further activities of this department will be discussed under the scientific research program of the Institute.

The Department of Public Relations and Trade endeavors to keep the press and public informed concerning the meat-packing industry and its products and to correct misinformation wherever it appears. The Department also prepares from time to time booklets, leaflets, charts, and similar advertising and publicity material, which, because of the fact that orders are consolidated and comparatively large quantities are printed, is supplied to member companies at relatively low cost. Coöperating with other departments of the Institute, much has been done, and is being done constantly, to promote the use of meat.

The Department of Scientific Research aims to develop information of great value to the industry on the science underlying its operations and thus to conserve and improve the products of the industry. It also helps in advising member companies concerning its problems and in thus functioning it works with other departments, such as the Department of Packinghouse Practice and Research or the Department of Nutrition. The problems attacked, the methods employed, and the results are of sufficient interest to the chemist and educator to warrant separate and more detailed presentation. This will be made in an article to follow.

To aid in providing a trained personnel is the function of the Department of Industrial Education. Through the work of this department and the coöperation of the Institute of Meat Packing at the University of Chicago, hundreds of men in the packing industry have been benefited from evening and home-study courses in packinghouse subjects. In addition a considerable number of men expecting to enter the packing industry have

been given special training in packinghouse subjects presented as regular daytime courses at the University of Chicago. This educational work will be presented in more detail later.

Commissions of the Institute

There are in the Institute structure three commissions constituted for the carrying out of certain special functions.

The Institute Plan Commission supervises the working of the plan brought forward in 1922, which provided for the addition to the Institute's activities of research and educational functions. The Departments of Scientific Research, Packinghouse Practice and Research, and Industrial Education were created under this plan and financed by funds collected for this purpose. While originally these funds were collected independently they are now added to the regular dues and collected from all members.

The Commission on the Elimination of Waste not only carries on the fight for waste elimination but was instrumental in obtaining the industry's approval of the Code of Trade Practices for the elimination of unfair and uneconomic practices which have existed in the buying of livestock and the selling of meat and products from meat-producing animals. The code was adopted October 22, 1929, by the American meat-packing industry and approved on November 12, 1929, by the Secretary of Agriculture. Not only are faulty existing practices weeded out by this code but it also serves to discourage and prevent the growing up of newer weeds to take the place of the old.

The Commission on Inspection has for its special function the bringing about of uniform meat inspection throughout the United States. The Institute believes this will be of benefit to all packers and to the purchasing public. At present those meat packers who engage in interstate commerce are subject to the inspection of the federal Bureau of Animal Industry. This inspection is effective and efficient. Those packers doing only an intra-state business are not obliged to submit to federal inspection but may be subject to the state or municipal code governing the packing industry of the state or municipality in question. The state or municipal code may or may not be adequate in itself for the task. In some few instances state laws are more drastic than federal regulations but in general they aim to follow the lead of the Bureau of Animal Industry or the regulations of the Food and Drug Administration. State or municipal inspection may prove to be inadequate because of insufficient funds and personnel for its endorsement. This is not a satisfactory state of affairs for either the public or the industry. The public should have a nation-wide, uniform inspection for its protection. Uniformly good quality products are more readily sold to the satisfaction of all than is a product which may be below standard, even if this occurrence is comparatively rare.

This commission is made up of representatives of packers subject to local and state inspection as well as packers subject to federal inspection. The Commission expects to draft a suggested uniform meat inspection law which would not only be in force as a federal law but would also be adopted by the states of the union. A great amount of work lies ahead of this Commission but it is confidently believed that the stated objectives will be gained.

Institute Laboratories

Some of the research activities of the Institute are carried on in the Research Laboratory of the Institute of American Meat Packers founded by Thomas E. Wilson at the University of Chicago. This laboratory is located in a building of the university connected with the medical group. The Director of the Department of Scientific Research is in charge and three qualified research men are devoting their full time to the work. In addition, by means of research grants or fellowships, other research activities are carried on at colleges and universities. Some of these studies include work on the cooking of pork cuts, lard and its use in the baking industry, swine-type study to develop the best type of swine from the viewpoint of both packer and producer, a study on the prevention of seedy cuts of bacon, and a study of the bacteriology of ham souring.

The Institute also operates a service laboratory to which member companies may send products which they wish to have analyzed for plant control and sales purposes. The Director of the Department of Scientific Research is in charge of this laboratory. Expert chemists perform the work at relatively low cost. Member companies may also take advantage of a consulting service which the Institute offers through this laboratory in consultation with the staff directors. In this way they may obtain specific directions for improving the product or removing any difficulties revealed by the analysis coupled with a description of present procedure.

CORRECTION

Dr. Ralph E. Oesper has kindly called our attention to a rather sad error which we coöperated in perpetrating on p. 1846 of the September, 1931, JOURNAL. The implied announcement of Dr. Ostwald's death is, happily, premature. Dr. Ostwald is still very much alive and quite actively engaged in his researches on colors.

Dr. Ostwald is a historical figure of such proportions that the author's error in conferring immortality upon him is understandable. We should have caught the mistake, however.

ANALYSIS OF MATERIALS OF THE MIDDLE BRONZE AGE

WM. B. MELDRUM AND ARTHUR E. PALMER, HAVERFORD COLLEGE, HAVERFORD, PENNSYLVANIA

In this paper are given the results of an analytical examination into the composition of various articles from Beth Shemesh, Palestine, chiefly metal articles and residues from jars. These were furnished by Dr. Elihu Grant, who as head of the Haverford Archeological Expedition has carried out extensive excavations at the site of this old city of the Canaanites. At three distinct levels the remains of as many cities were found, the lowest, at bed rock, being that of the ancient Canaanites who dwelt there long before the occupation of Palestine by the Hebrews. Beth Shemesh, although not directly on the main caravan route between the two great centers of civilization, the valley of the Nile and the valley of the Euphrates, was not far removed from it and was much used by travelers over this route. Accordingly, and as evidence of trade with both east and west, in addition to the essentially plain pottery of the Canaanites were found decorated pottery from Cyprus and metal articles of fine artistry from Cyprus, Crete, and Egypt, and, it may be, from Mesopotamia also.

The value of such data as are presented here lies, for the most part, in the indication which they may give as to the sources of raw materials, the methods of extraction and fabrication, to the course of trade, to the customs and mode of living of the users, and to the fixing of the period of their production—all in coördination with information from other sources. Quantitative data of this sort seem to be rare in the literature.

The metal articles analyzed were mostly classifiable as bronzes. It is fairly certain that these were of Egyptian origin or at least of Egyptian fabrication, the copper coming from the mines of the Sinai peninsula or possibly from Cyprus, and the tin being supplied by the Phoenicians, who even at so early a date were the sailors of the Mediterranean. There is no evidence that there was tin ore available in Egypt or its immediate environs.

Some of the analytical results obtained are given in Table I. The letters in the first column indicate the object as given in the list below. In the last column are given the ratios of copper to tin, which, as our evidence shows, may be taken as very nearly the ratio in the original uncorroded metal itself although determined from badly corroded samples. In addition to analyses shown, arsenic was found in traces in all samples except A; iron in traces in all samples except D; zinc except in G and J. Silver was found in traces in a few of the samples indicating crudity in methods of separation of the metals.

These results in the main bear out the testimony offered by Lucas (Ancient Egyptian Materials, A. Lucas, p. 235) that over a lengthy period, from the third to the eighteenth dynasty, no definite progress

TABLE I

	Copper %	*Tin* %	*Lead* %	*Miscellaneous* %	*Ratio, Cu:Sn*
A	63.8	5.2	0.5	0.28 Gold Trace Silver	91:9
B	70.8	13.9	1.3	0.20 Zinc	84:16
C	55.4	9.6	0.2	...	85:15
D	85.9	2.7	0.6	...	97:3
E	70.9	8.8	Trace	...	89:11
F	88.7	9.7	Trace	...	90:10
G	50.6	12.7	2.8	5.6 Sulfur Trace Silver	80:20
H	66.8	5.2	Trace	...	92:8
I	47.0	18.5	Trace	Trace Silver	72:28
J	0.1	..	2.9	57.23 Silver Trace Gold	
K	67.7	12.5	0.1	...	84:16
L	54.5	6.2	0.3	...	90:10
M	91.6	5.6	0.5	...	94:6
N	90.9	5.3	Trace	Trace Silver	94:6

A. Spearhead found in débris thrown outside city wall by the early inhabitants. The presence of gold in such large proportion indicates that the spearhead was made from scrap metal containing gold.
B. Fragments. Badly corroded.
C. Fragment of a small bronze crescent. Badly corroded.
D. Needle from cemetery of middle bronze age. Inner core not corroded.
E. Arrow head from city débris. Badly corroded.
F. Bronze bar, weight 107 grams, 7 × 9 cm., found in second level (late bronze). Inner core, free from corrosion, taken for analysis.
G. Corroded lump from lowest level. This was the only sample carrying an appreciable proportion of sulfur. May indicate ore imported for working at Beth Shemesh. No such minerals occur in Beth Shemesh region.
H. Arrow head found in lowest level (early bronze). Badly corroded.
I. Possibly a mirror. Found in city débris. Entirely corroded.
J. Silver crescent, possibly harness ornament. Badly corroded. From second lowest level (middle bronze).
K. Possibly a needle or punch point. Badly corroded.
L. Fragments of ear rings taken from a jar. Entirely corroded.
M. Curved needle. Only slightly corroded. Probably of early iron age. Found near surface.
N. Lump. Badly corroded.

seems to have been made in the manufacture of bronzes in Egypt. Methods of weighing were crude, raw materials were of varying degrees of purity, and frequently scrap metals were employed. Lead varies from 0 to 8.5%; arsenic was almost invariably present, sometimes in appreciable amounts. The proportion of copper to tin in twelve articles covering a range of 15 dynasties varied from 81:19 to 98:2 but not regularly. Lucas does not, however, report either gold or silver in his analyses. In

general the Canaanite bronzes seem to run somewhat higher in tin than do the ancient Egyptian bronzes.

To determine whether or not the analysis of the corroded metal represented in the proportion of copper to tin that of the bronze itself, sample F was carefully separated into corroded and non-corroded portions and the two analyzed. The results are given in Table II.

TABLE II

Metallic Core			*Crust*		
Copper %	*Tin* %	*Ratio Cu:Sn*	*Copper* %	*Tin* %	*Ratio Cu:Sn*
88.7	9.7	90:10	69.7	8.2	89.6:10.4

Photomicrographs made for us by Mr. U. S. Johnson, of the University of Minnesota, using the uncorroded sample F showed inclusions of non-metallic impurities. They also indicate that the material was forged, not cast, the forging being done at a temperature below 500°C.

Two other analyses, on non-metallic materials, seem to be of worth while significance. One was on the residue found as an incrustation in a large earthenware jar, about three feet in height and two foot across at the middle, found in a cemetery vault of the middle bronze age. At first it was thought that this jar might have been used as a water reservoir, the incrustation being such as might be expected as a residue from hard water. The results of analysis, which are as follows, showed that this was not at least the only use.

Calcium oxide.....	36.40%	Carbon dioxide.....	39.40%
Magnesium oxide.....	9.91	Phosphorus pentoxide..	0.26
Ferric oxide.....	3.00	Chloride.....	0.12
Fluoride.....	Definite trace		

Traces of potassium, sodium, silica, and organic matter were also found. The ether extract of the incrusted residue when evaporated to dryness yielded a practically unweighable residue which gave a very definite pungent odor exactly similar, so far as could be judged, to that of gum benzoin. This fact, together with the high phosphorus and distinct trace of fluorine, indicated that the jar had been used either as an interment jar in which remains had been placed after cremation or as a "vase of sins." There is little doubt that cremation was practiced among the Canaanites (Grant, Beth Shemesh, p. 76); however, the absence of charcoal particles as well as the low percentage of phosphorus tend to refute the idea of the sample in question being cremation ashes. The vase of sins was used by the Egyptians at this period; they made a practice of placing the stomach, intestines, brains, and heart of a dead person in a jar and setting this in the grave beside the body.

The second analysis referred to was on ashes collected near the spot where a fine bronze shovel in a state of preservation almost perfect had been found. Near the same spot had stood the statue of Astarte, the goddess of fertility, in the ancient temple. On this spot sacrifices, it may be human sacrifices, had been made. Although the ashes collected were mixed with quantities of clay and charcoal particles they showed a content of 0.5% phosphorus and gave a distinct qualitative test for fluoride.

Sky's Blue Caused by Electricity from Sun. Electrons streaming from the sun may be the cause of our familiar but mysterious blue sky, Dr. Willi M. Cohn, of the University of Berlin, has concluded as the result of his experiments in which a blue light very similar to that from the sky was produced in the laboratory. Dr. Cohn is doing high-temperature research at the A. D. Little laboratories and will start researches at Harvard in the fall.

Dr. Cohn experimented in Berlin with cathode rays in a high vacuum, formed in a tube similar to the X-ray tube. He allowed the stream of electrons, which is the cathode ray, to meet larger electrically charged particles of matter, known to scientists as ions, which are formed either from a piece of radioactive metal, such as thorium, or from a gas. The blue light appeared where the electrons and the ions came together.

This blue light can be broken up by prisms to form a spectrum or "rainbow" of continuous color, just as is found in sunlight. The blue light from the clear sky also shows a continuous spectrum, although gases, such as the air this light passes through, have quite different spectra, which show only thin colored lines. Dr. Cohn points out that at the upper layers of our atmosphere electrons continually arriving from the sun and ions of the gases which form our air meet in the intense vacuum of space. Since under such conditions in his laboratory the blue light which is so like the light from the blue sky is formed, he believes that the blue of the heavens may, at least partially, have the same cause as that of the laboratory.

Since the time of Newton scientists have speculated on why the sky is blue. The most successful explanation heretofore has been that of Sir John Tyndall and Lord Rayleigh in the last century, which considers it due to sunlight broken up in a particular way by spherical particles in the atmosphere. Dr. Cohn states that his theory does not conflict with the older one so far as direct sunlight is concerned. He points out that the Tyndall-Rayleigh theory would expect the light from the sky to be polarized so that all its waves would vibrate in a particular way. The light produced by Dr. Cohn in the laboratory is not polarized, and daylight is only partly polarized, partly not.—*Science Service*

New Car Cooling System Uses Only Steam and Water. Steam and water are the only agents used in a new system of cooling for passenger coaches demonstrated recently before a group of railway and Pullman executives. The method depends on the long-known physical principles, that when water evaporates it absorbs much heat in the process, and that the temperature at which this evaporation will take place can be greatly lowered by reducing the air pressure above the water.

The new mechanism injects steam into a tank of water in such a way as to create a vacuum above it. Evaporation then reduces the water to a temperature of 40 degrees Fahrenheit. The cooled water is circulated through coils, over which air is drawn and then blown into the car. The process is said to be almost entirely automatic.—*Science Service*

THE CHEMISTRY OF SOME SUGGESTED INSULIN SUBSTITUTES

CHARLES E. BRAUN, UNIVERSITY OF VERMONT, BURLINGTON, VERMONT

Some reasons are advanced for desiring a substitute for insulin. The more important substances suggested to date for this purpose are divided into two groups, namely, those of known constitution and those of unknown structure. The first division is discussed from the points of view of occurrence, structure, and synthesis, and includes galegine, agmatine, the synthalin types, acoin, and other aromatic guanidines and acridines. The second group treats the sources and methods of preparation of substances possessing hypoglycemic properties obtained from yeast and other plant tissues, and clam tissue.

The method of administration and pharmacological action of each substance is briefly discussed and compared with insulin. The value of these suggested insulin substitutes as therapeutic agents in the treatment of diabetes is considered.

. . . . . .

Introduction

The question may be asked, why is an insulin substitute desirable when the pancreatic hormone is so effective in the treatment of diabetes mellitus. There are several good reasons for seeking an insulin substitute.

Insulin as prepared today from pancreas tissue contains some extraneous protein materials as impurities. It is true that the more refined and improved methods for pancreas extraction have eliminated to a considerable degree many of the protein impurities which were present in the earlier preparations. Nevertheless there are present even in the modern clinical preparations sufficient protein impurities to cause a protein reaction in some patients and thus prevent them from using insulin.

Also the method of administration of insulin, namely subcutaneous injection, is objectionable from several points of view. Hypodermic injection always involves the danger of infection unless the usual aseptic precautions are taken. To properly protect oneself against bacteria and to administer the insulin dosage by injection requires a certain degree of surgical knowledge and technic, both of which can be taught only to individuals of at least average intelligence. Unfortunately, many diabetics are people of low mentality and cannot be trusted to administer insulin to themselves or have members of their families administer it to them. The result is that such people must attend regularly clinics or hospitals for their insulin treatments. This has a tendency to overload the clinics. Aside from the danger of infection, hypodermic administration of insulin is not only painful, but is also very troublesome and under certain circumstances rather difficult to carry out.

Because of the above reasons, efforts have been and are being made to find something which may be used in place of insulin in the treatment of

diabetes. The best substitute would be one which would be active by oral administration, thus eliminating the undesirable injection. An insulin substitute also must have a very low toxicity, at least as low as insulin itself, and cause no secondary reactions. Naturally it must have pharmacological properties similar to those of insulin, especially producing rapidly a marked decrease in blood sugar. The latter property, shown by insulin, makes it extremely valuable in the treatment of diabetic coma.

The problem of finding a suitable substitute for insulin is complicated by the fact that the exact chemical nature of insulin is still unknown. Nevertheless several substitutes have been suggested to date. For purposes of classification these can be divided into two groups; compounds whose chemical structures have been determined, and substances of unknown constitution.

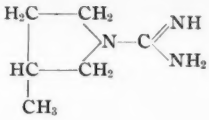
Compounds of Known Constitution

GALEGINE

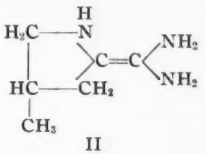
The pharmacological investigations of galegine by Müller (*1*) and by Simonnet and Tanret (*2*) revealed the interesting fact that salts of this alkaloid will produce a hypoglycemia when orally administered. However, it was also noted that there was but a slight margin between the hypoglycemic and the lethal dose, indicating a high toxicity. Despite this serious objection galegine has been suggested as a substitute for insulin.

Galegine is not a new compound. It was first isolated by Tanret (*3*) from the seeds of the *Galega officinalis* by extraction with 60% ethyl alcohol and subsequent treatment of the extract with sulfuric acid. In this manner Tanret obtained the base as its sulfate salt. By treating this salt with sodium hydroxide he succeeded in isolating the free base. The latter had the empirical formula $C_6H_{13}N_3$ and melted between 60° and 65°. The sulfate salt was water soluble, bitter to the taste, and was readily precipitated by alkaloidal precipitants such as picric acid, potassium mercuric iodide, and tannic acid.

The problem of the structure of galegine was first attacked by Tanret (*4*), who showed that it was optically inactive, could not be resolved into *d*- and *l*-isomers, contained one double bond, and was decomposed into ammonia and an organic base (b. p. 105–8°) by heating in a glycerine bath at 180–190°. Tanret assumed that the base had the following structure: $CH_3—\overset{H}{C}—CH_2—CH_2—\overset{H}{N}—CH_2$. By heating galegine in sealed tubes with barium hydroxide he obtained urea and the base referred to above. On the basis of this experimental evidence Tanret gave two possible structures, I and II, for galegine, but considered II the more probable.

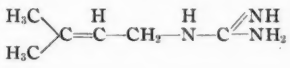


I



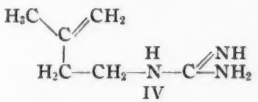
II

Barger and White (*5*) also studied the structure of galegine and found that upon hydrolysis it gave urea and a volatile base, which was shown to be aminoamylene. Upon this evidence these investigators assigned to galegine the following formulas:



III

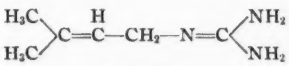
or



IV

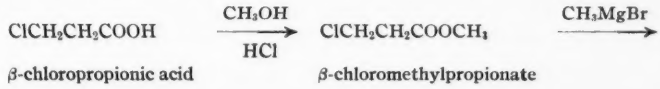
The suggestion of a branched carbon chain in galegine was in agreement with Tanret (*6*) who favored formula IV.

Späth and Prokopp (*7*) working on the structure of galegine hydrogenated the alkaloid catalytically over paladium and obtained a dihydrogalegine. The latter upon decomposition with barium hydroxide produced isoamylamine and urea. Further, galegine was found to produce acetone when oxidized by potassium permanganate; a transformation which would be rather improbable if formula IV were correct. From this experimental evidence these investigators concluded that galegine has the following constitution:



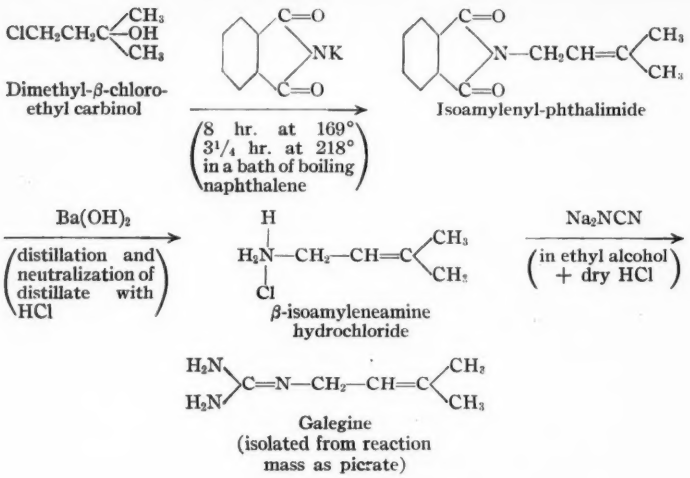
Galegine

The alkaloid was prepared synthetically in 1925 by Späth and Spitzy (*8*). By reacting β-chloromethylpropionate with methyl magnesium bromide they prepared dimethyl-β-chloroethyl carbinol. This was heated with potassium phthalimide in xylene at 169° in sealed tubes, the temperature finally being raised to 218°. The resulting product, β-isoamylenyl-phthalimide, was next distilled with aqueous barium hydroxide, and the distillate neutralized with hydrochloric acid, producing isoamyleneamine hydrochloride. The latter, when condensed with sodium cyanamid, gave galegine. These transformations involved the following reactions:



β-chloropropionic acid

β-chloromethylpropionate

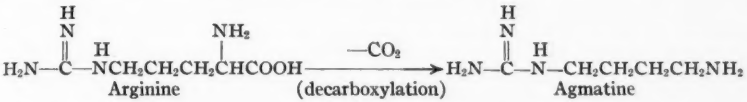


SYNTHALIN

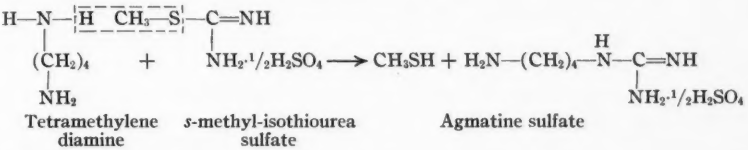
Probably the most important synthetic insulin substitute suggested to date is a polymethylene diguanidine type called synthalin. Before discussing the chemistry of this compound, it may be of interest to consider some of the facts which led to a consideration of guanidines as possible insulin substitutes.

In 1914 Underhill and Blatherwick (*9*) showed that during the tetany following thyreoparathyroidectomy the blood sugar content was markedly lowered. Burns and Sharpe (*10*) two years later reported that after parathyroidectomy the guanidine and methylguanidine content of the blood and urine of dogs was greatly increased. About the same time Paton and Findlay (*11*) found that symptoms almost identical with those of tetania parathyreopriva could be produced in rabbits by the administration of salts of guanidine and methyl guanidine. The results of these researches led Watanabe (*12*) in 1918 to investigate the effect of injecting guanidine derivatives upon the sugar content of the blood. He demonstrated that the administration of guanidine hydrochloride into rabbits produced symptoms which were almost identical with those of tetania parathyreopriva, and at the same time cause a hypoglycemia which also occurs after the removal of the parathyroid. From this Watanabe concluded that "the hypoglycemia resulting from lack of parathyroid may be due to the action of guanidine which is increased in the blood under these conditions." This work therefore produced the information that derivatives of guanidine may cause hypoglycemia, and led to the investigation of guanidine types as possible insulin substitutes.

The most important forerunner of synthalin was agmatine, 1-guanidino-4-amino-butane. This compound is closely related to arginine, being produced from the latter by loss of carbon dioxide.



Kossel (*13*) in 1910 succeeded in isolating agmatine from herring sperm after heating the tissue with sulfuric acid in an autoclave under a pressure of four atmospheres. He then proved it to be guanidino-amino-butane by synthesizing it by a rather unsatisfactory method which involved silver cyanamid, carbon dioxide, and tetramethylene diamine (*14*). By an application of the Rathke synthesis (*15*) for guanidines, Heyn (*16*) recently developed a more practicable method for preparing agmatine. He reacted tetramethylene diamine with *s*-methyl-isothiourea sulfate (*17*) in concentrated aqueous solution on a boiling water-bath, and obtained an 80% yield of amino-butyleneguanidine sulfate or agmatine sulfate. The probable mechanism of this reaction is as follows:



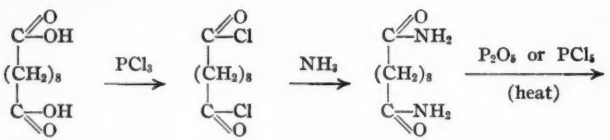
Following the lead of Watanabe (*12*), Frank, Nothmann, and Wagner (*18*) investigated the hypoglycemic properties of agmatine, and found that it not only decreased the blood sugar, but also was less toxic than guanidine itself. These results led Frank and his co-workers to continue their guanidine researches which resulted in the discovery of synthalin.

Having found agmatine to be physiologically active, Frank next investigated the effect upon the hypoglycemic properties of lengthening the carbon chain. This attack seemed logical in view of the fact that in the urethanes, alcohols, and pinacones the narcotic effect increases with the number of carbon atoms in the branched side chain, and a similar relationship holds for the effect of primary amines on the sympathetic nervous system on passing from butylamine to hexylamine. Using pentamethylene diamine and hexamethylene diamine in the Heyn (*16*) synthesis two homologs of agmatine were prepared, namely, 1-guanidino-5-amino-pentane and 1-guanidino-6-amino-hexane, and their pharmacological properties determined. Physiologically these compounds very closely resembled agmatine. The pentamethylene derivative was more active and probably less toxic than agmatine. The hexamethylene derivative showed such

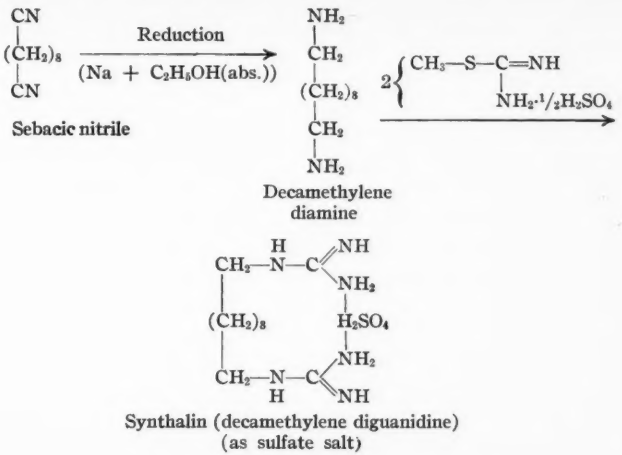
a very slight advantage over the pentamethylene compound that Frank abandoned the idea of preparing additional homologs of agmatine and resorted to a different type of structure change in his attempts to produce increased hypoglycemic activity and lower toxicity.

The structural alteration referred to was a change from monoguanidines to diguanidines. Heyn (*19*) found that by using the same reagents, namely, polymethylene diamines and salts of *s*-alkyl-isothioureas, but doubling the molecular ratio of the latter, diguanidines instead of monoguanidines were produced. Using this method of preparation, Frank and his co-workers probably synthesized a large number of polymethylene diguanidines and studied their pharmacological properties. The diguanidines were found to exert a more pronounced hypoglycemic action and were less toxic than the monoguanidines, agmatine and its homologs, discussed above. The most active of the diguanidines investigated was decamethylene diguanidine. Frank (*18*), (*20*) in 1926 suggested this compound as an insulin substitute under the name of synthalin, a name given in 1913 to a methyl-piperonyl-quinoline carboxylic acid (*21*).

Synthalin (*19*) was prepared by condensing decamethylene diamine (1 mole) with *s*-methyl-isothiourea sulfate (2 moles) in aqueous solution on a boiling water-bath until methyl mercaptan no longer was evolved. Upon acidification with dilute sulfuric acid and subsequent cooling, synthalin, decamethylene diguanidine as its sulfate salt, crystallized out. No mention was made by Heyn (*19*) as to the source or method of preparation of decamethylene diamine. The latter was synthesized from sebacic acid by Kumagai, Kawai, Shikinami, and Hosono (*22*), and also in this laboratory (*23*) by a series of well-established reactions. The sebacic acid was prepared from castor oil by dry distilling the sodium soap with caustic soda in an iron retort (*24*). The acid was converted into its acid chloride with phosphorus trichloride, and the crude chloride was transformed directly into the amide by reacting it with concentrated ammonia (*25*). From the amide the nitrile was obtained by dehydration with phosphorus pentoxide or pentachloride and subsequent distillation under reduced pressure (*26*). Reduction of the nitrile with sodium and absolute alcohol produced decamethylene diamine (*27*). The reactions involved in the preparation of 1,10-diaminodecane from sebacic acid, and the condensation of the diamine with *s*-methyl-isothiourea sulfate to produce synthalin are as follows:



Sebacic acid Sebacic amide



Synthalin (decamethylene diguanidine)
(as sulfate salt)

Synthalin was not the only polymethylene diguanidine prepared and studied by Frank and his co-workers, and the latter group were not the only investigators to synthesize diguanidine types and determine their pharmacological properties. Kumagai, Kawai, and Shikinami (*22*), (*28*) prepared not only a series of homologous polymethylene diguanidines, but also amino guanidines and some guanidines containing heterocyclic nuclei, and studied their physiological action. These investigators concluded that hexamethylene diguanidine was equal to synthalin (decamethylene diguanidine) in hypoglycemic properties. Bischoff, Sahyun, and Long (*29*) prepared a very large number of guanidine derivatives and determined their physiological properties. Their guanidines included beside the polymethylene types, some heterocyclic guanidines and a series of aromatic guanidines. A very interesting result brought out in the work of Bischoff, Sahyun, and Long is that a guanidine derivative which showed no toxic effects also possessed no hypoglycemic properties.

In 1928 Frank, Nothmann, and Wagner (*20*) announced a synthalin B or neosynthalin which was claimed to be less toxic than synthalin but otherwise had similar pharmacological properties. Neosynthalin differed from synthalin in containing 2 more methylene groups, or was dodecamethylene diguanidine, $H_2N—\overset{\overset{N}{\|}}{C}—\overset{\overset{H}{|}}{N}(CH_2)_{12}—\overset{\overset{H}{|}}{N}—\overset{\overset{N}{\|}}{C}—NH_2$. After studying the hypoglycemic action of neosynthalin, Bischoff, Sahyun, and Long (*29*) reported that it was less toxic than synthalin and also was less active physiologically.

Although synthalin and neosynthalin have been suggested as possible insulin substitutes, their physiological effects compared with those of insulin show some decided differences. Both are considerably more toxic than insulin, usually producing, among other effects, serious kidney and liver damage after prolonged use. Also, synthalin types have a delayed action which makes them practically useless in treating diabetic coma. Furthermore, the effects of synthalin vary depending upon the severity of the case; in mild or medium diabetes it is more effective than in severe cases where in some instances not even a temporary favorable effect was observed. Although the true mechanism of insulin action is not yet thoroughly understood, nevertheless sufficient comparative data are available to warrant the conclusion that insulin action and synthalin action are not identical.

GLUKHORMENT

In 1927 another substitute for insulin was suggested by von Noorden under the name of glukhorment (*30*). This material was prepared from pancreas tissue by autolyzing it until guanidine acetic acid could be detected in the reaction mixture. The dry powder, glukhorment, when fed, was found to produce hypoglycemia. Von Noorden claimed that since glukhorment contained only a small quantity of guanidine derivatives these could not be responsible for the physiological effects observed. Furthermore, the method of preparation eliminated the possibility that the hypoglycemia was caused by the presence of insulin.

Bischoff, Blatherwick, and Sahyun (*31*), investigating synthalin and glukhorment, succeeded in isolating a guanidine derivative from the latter. The picrate, chloroaurate, and chloroplatinate of this guanidine were prepared and their melting points compared with those of similar salts made from synthalin and neosynthalin. The melting-point data obtained are as follows:

	Melting Points of Derivatives (°C.)		
Guanidine Compound	*Picrate*	*Chloroaurate*	*Chloroplatinate*
Synthalin	193	153	211
Glukhorment	191	152	209
Neosynthalin	190	117	206

From this they concluded that "the guanidine derivative existing in glukhorment is either synthalin or a near homolog of it."

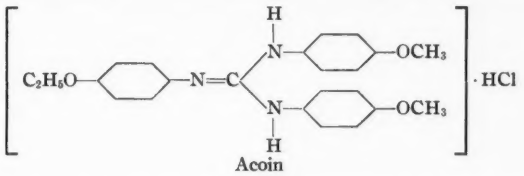
Langecker (*32*), after investigating glukhorment, also supported the conclusion of Bischoff, Blatherwick, and Sahyun, and presented additional data to show that the active constituent of this suggested insulin substitute is synthalin (decamethylene diguanidine).

AROMATIC GUANIDINES

The compounds discussed above in some detail were mostly aliphatic guanidines of the polymethylene type. Reference has been made, however,

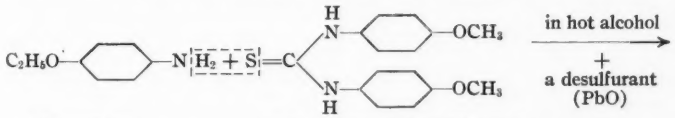
to a series of aromatic guanidines prepared and studied by Bischoff and his co-workers (*29*), who found that aromatic types generally were more toxic and less active from the point of view of producing hypoglycemia than aliphatic guanidines. From their results these investigators formulated the hypothesis that "the benzene nucleus was not productive of hypoglycemia." It is to be noted, however, that even though the aromatic guanidines failed to produce consistent hypoglycemia, in a few cases distinct hypoglycemic symptoms were noted, as for example with guanyl-*p*-dimethyl-aminoaniline and guanyl-benzidine. The same erratic behavior was observed recently (*33*) with another aromatic guanidine, namely, *p*-aminophenylguanidine in the form of its salts, which had been prepared by condensing *p*-phenylenediamine with *s*-alkyl-isothiourea salts.

On the other hand, a hypoglycemic action similar to that of insulin, together with low toxicity, was reported by Cannavo (*34*) in 1927 and 1928 for the aromatic guanidine acoin (sometimes acoine or acoin C). This compound has been available through Heyden and Company since 1897. [It was mentioned in the *British Medical Journal* (*35*) of 1899 as a new local anesthetic.] Acoin, chemically, is the hydrochloride salt of a tri-alkoxy derivative of triphenylguanidine, and has the following structure:

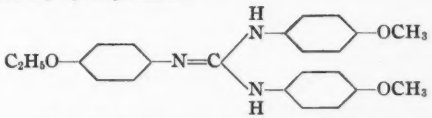


Acoin

It may be prepared synthetically (*36*) by condensing *p*-phenetidine with di-*p*-methoxy-diphenylthiourea in the presence of some desulfurant, such as lead oxide, according to the following reaction:



p-Phenetidine Di-*p*-methoxydiphenylthiourea



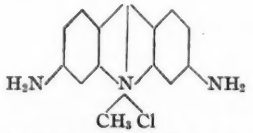
Di-*p*-anisyl, mono-*p*-phenetyl guanidine
[the HCl salt (m. p. 176°) is acoin]

Cannavo appears to have been the first to investigate the hypoglycemic properties of acoin, and on the basis of his results suggested its use as a

therapeutic agent in the treatment of diabetes. It may be of interest in this connection to note that although Cannavo reported excellent results with acoin, a di-methoxy, mono-ethoxy-triphenylguanidine, Bischoff and his co-workers (*29*), on the other hand, reported triphenylguanidine to be the most toxic of the six aromatic guanidines investigated.

ACRIDINES

Recently derivatives of acridine have been investigated from the point of view of their value in the treatment of diabetes. The idea underlying this work was that perhaps some of the conditions noted in diabetes may have an infectious origin. Nielsen (*37*) studied the effects of two acridine derivatives, septacrol, an acridine compound containing 22.3% silver, and the well-known antiseptic trypaflavine or acriflavine, 3,6-diaminomethylacridinium chloride.



Trypaflavine or Acriflavine

The latter was originally introduced as a trypanocide by Ehrlich. Since it was reported that their effects upon the blood sugar were inconsistent and that their behavior was quite unlike that of insulin, it does not seem significant to consider these two acridine derivatives in detail.

Substances of Unknown Constitution

Under this classification two subdivisions logically find places, namely, suggested insulin substitutes derived from plant tissue, and substitutes derived from clam tissue. The first subdivision is by far the more important and has opened up some interesting research possibilities.

PLANT TISSUE

Yeast.—In 1923 Collip (*38*) announced the hypothesis that glycogen formation is definitely a pancreatic hormone function, and therefore, from a purely speculative point of view, wherever glycogen was found one might expect to find a similar hormone. Working upon this theory, Collip (*38*) investigated yeast as a source of insulin-like material, and succeeded in obtaining from it a substance which, when subcutaneously administered, produced a marked hypoglycemia in normal rabbits and decreased the level of the blood sugar in depancreatized dogs. One important difference was noted, namely, that the material obtained from yeast developed its physiological effects more slowly and maintained them longer than insulin. To this hypoglycemic substance Collip assigned the name glukokinin.

Developing his extraction technic and extending his investigation to other plants, Collip prepared a material similar in physiological properties to glukokinin, from several plant tissues, including lawn grass (*39*). Briefly Collip's technic for obtaining an active substance from plant tissue was as follows. The tissue was first made permeable by autoclaving it for a short time (up to 20 minutes) at a steam pressure of not more than 5 pounds. It was then transferred to a press and the sap pressed out. The crude active material was precipitated from the fresh sap by the addition of ammonium sulfate, and then purified by treatment with alcohol or acetone. Although no formula or structure was advanced for the active materials just mentioned, it is interesting to note Collip's speculation (*40*), "There is a possibility, but it is only a possibility, that insulin, guanidine, and certain constituents of plant extracts are related chemically in some fundamental manner." This thought takes on some degree of significance in the light of the latter developments of the synthetic guanidines and diguanidines described above.

Confirmation of the preparation of a hypoglycemia-producing material from yeast was reported by Hutchinson, Smith, and Winter (*41*). These investigators incubated their yeast for 24 hours at 26° in contact with disodium hydrogen phosphate and boiled white potatoes before extracting the active substance from the tissue, and in this manner obtained better yields than by the Collip method. However, with various samples of yeast, varying yields were obtained despite the preliminary incubation treatment. Further confirmation of the extraction of an active substance from yeast was reported by Winter and Smith (*42*), Hutchinson, Smith, and Winter (*43*) and more recently by Kaufmann (*44*).

Other Plant Tissues.—Reference has already been made to the preparation of a hypoglycemic substance from plant tissue other than yeast (*39*). Upon extending his researches dealing with plant sources of an insulin-like material, Collip (*45*) succeeded in isolating such a substance from onion tops, onion roots, barley roots, green wheat leaves, bean tops, and lettuce. The wide distribution of this hypoglycemic material (if it is only one substance) was even extended by the work of Best and Scott (*46*) who prepared active extracts from potatoes, rice, wheat, beet roots, and celery. Kaufmann (*47*) recently reported hypoglycemic results, erratic and not as marked as with insulin, with extracts of bean husks. He advanced the idea that the variations in the results may be due to differences in the ripening season. Continuing his work with plant tissues, Kaufmann (*48*) prepared extracts possessing hypoglycemic properties from peas, lentils, beans, oats, rye, and wheat. In rabbits peroral feeding of these extracts produced a lowering of the blood sugar, beginning in 2 to 3 hours and reaching a maximum in from 6 to 8 hours, an action considerably slower than that shown by insulin. In a comparative series, the blood sugar reducing

power of these extracts was found to be in the order of oats, beans, peas, lentils, wheat, and rye (*49*). Kaufmann (*50*) also investigated the hypoglycemic properties of extracts of jambul bark, and concluded that they are of little value in the treatment of diabetes.

CLAM TISSUE

On the basis of his glycogen formation hypothesis (*38*) Collip investigated clam tissue as a possible source of an insulin-like substance. Using the same extraction technic as was used for the isolation of insulin from ox pancreas, he was able to produce from clam tissue (*51*) an extract which gave typical hypoglycemic convulsions after six hours. Here again, as with the plant tissue extracts, no pure substance was isolated, and no formula or structure was suggested.

Conclusion

Although several materials have been suggested to date as insulin substitutes, from the clinical data available one must conclude that nothing yet developed can replace the pancreatic hormone as a therapeutic agent in the treatment of diabetes. However, this conclusion does not signify that all of the efforts described above have been futile and of no avail. On the contrary, they have been the stimuli for further research; they have contributed much to the problem of chemical constitution and physiological activity, at least in the field of guanidine derivatives; and they have opened up a line of investigation which should bring valuable results in the future. It is true that what has just been said pertains chiefly to the compounds of known constitution, but even those of unknown structure, the plant extracts, have made their contribution. It would be extremely interesting to isolate in pure form the active principles from these extracts and determine, if possible, their chemical nature. Are they insulin, synthalin, or some type of compound which has not yet been considered in the search for an insulin substitute?

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AN EXPERIMENT IN TEACHING CHEMICAL ENGINEERING

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The method of instruction described includes informal class discussions, student reports on assignments, individual conferences, oral quizzes, and a written final examination. Set recitations and lectures are largely eliminated, and laboratory work proceeds at a rate determined by the ability and application of the individual student.

. . . . . .

In an effort to make the presentation of the various phases of chemical engineering more effective and interesting, a variation from the usual systems of teaching the courses was tried during the fall quarter of 1930 by the Department of Chemical Engineering at Montana State College. The essentials of the system which was used were suggested to a great extent by the principles which are outlined in the Whetzel method of teaching.* However, certain important modifications were included to adapt this method to the teaching of chemical engineering. The particular course in which the experiment was carried out dealt chiefly with the unit processes of crushing, grinding, and mechanical separation and was taught to third and fourth year college students.

Primarily, the system placed especial emphasis on the development of the initiative for study within the individual. Like other experiments in teaching, it was also intended to instil in the students a thorough knowledge of the material covered, essentially through a more effective and appealing method of presentation. The procedure that was followed was somewhat different (probably not entirely in some cases) from those which are usually employed in teaching chemical engineering.

Recitations and lectures, as such, were in large part eliminated; in their stead were held regular meetings of the class under the supervision of the students. These meetings were nearly always of an informal nature and usually consisted of open discussions of the various subjects and assigned problems of the course, or of questioning of the instructor. At frequent intervals talks, prepared from the literature, were delivered by various members of the class. The purpose of these speeches was three-fold: to give the student practice in the effective presentation to others of information which he has acquired, to make available to the class material not specifically covered in the text, and to train the student in systematic search of the literature of chemical engineering. Aside from answering the questions which were directly asked him, the teacher's position at these meetings was merely that of an onlooker and arbiter. However, the essential details of the material covered at each meeting were always kept

* WHETZEL: "An Experiment in Teaching." Presented at Chicago, Illinois, before the Sub-section of Resident Teaching of the Association of Land Grant Colleges and Universities, November 13, 1929. Published in *Sci. Mo.*, **31**, 151–62 (Aug., 1930).

in mind by the instructor, who made it a point to call the attention of the group to any of these particulars that may have been overlooked.

The material to be studied was divided into three principal divisions or assignments, namely: crushing, grinding, and mechanical separation. In addition, type problems were presented frequently during the quarter. At the first meeting of the class the subject matter and the method of procedure were outlined, and the major assignments were made. A well-known chemical engineering textbook was used as a basis for the course, but frequent references were also made to standard works on chemical engineering, industrial chemistry, metallurgy, and similar subjects. The progress of each student was left entirely to himself, since few daily class assignments were made. Similarly, at the first laboratory meeting of the class the assignment of the entire laboratory work for the quarter was posted and each student was allowed to advance as rapidly as he pleased.

Excepting the final examination, written tests were entirely eliminated. In their place individual conferences were held between each student and the instructor. These interviews were arranged at the student's request and covered each division of the assigned work as soon as it was mastered. At these conferences problems concerning the topic under consideration were placed before the student. An oral, reasonably prompt reply was expected. The problems were usually of such nature that the student was forced to draw primarily on the principles involved; factual matter was largely supplied by the instructor. The following questions serve well as examples of the test-problems which were used:

It is desired to reduce one hundred tons of lime-rock per day from an average diameter of six inches to an average diameter of three-eighths of an inch. Describe in detail the crushing plant which you would build for this purpose and explain why you design it as you do.

A company, operating a 150-ton phosphoric acid plant, desires to remove the calcium sulfate from the pulp with a minimum loss of acid. Describe the methods and equipment which could be used and explain the principles involved.

When the problem was disposed of, the instructor was open to question or discussion on any phase of the material dealt with. At the end of each conference the student was asked if he was satisfied with his knowledge of the topic as indicated by his report. If the answer was in the affirmative, the grade for the report was recorded as final for that portion of the course work. If the answer was negative, no grade was given and arrangements were made for another conference at the student's earliest convenience.

Aside from the final examination these meetings with the individual students were the instructor's chief guide in determining the grades of the various members of the class. For this reason the conferences were usually

quite vigorous and thorough in nature. The following chart, designed by the department, was used in grading:

MONTANA STATE COLLEGE

DEPARTMENT OF CHEMICAL ENGINEERING

Grade Chart for Guidance in Conference Examinations

Reaction of student to the problem proposed	*Grade*
	100
Displays marked initiative and judgment in meeting the situation. Quickly senses the application of principles and previous knowledge to the new problem.	A
	90
Needs some suggestion and direction to get him to thinking clearly but once started on proper line of reasoning, he proceeds to a logical conclusion.	B
	80
Has clear-cut understanding of facts and theories but must be led to apply them to a problem not previously encountered.	C
	70
Has hazy conceptions of facts and theories and misconstrues their application to the problem.	D
	60
Has no knowledge of facts or theories necessary for an understanding of the problem.	E
	50

The system was tested during a period of about three months. Its principal disadvantage was found to be that the conferences occupied a considerable portion of the instructor's time. This difficulty was remedied in part by the policy of bringing to an immediate halt those conferences in which the first few minutes of the report, augmented by two or three general questions, clearly indicated that the student's knowledge was either entirely satisfactory or unsatisfactory.

Against the above-mentioned inconvenience can be balanced the following advantages:

It was an unusually effective method of imparting knowledge to students.

It automatically eliminated cheating and offered a very decisive method of distinguishing the earnest and interested student from the lethargic.

By allowing more class time for questions and discussion, it gave the student a much better opportunity to clear up any difficulties which he may have encountered in the text.

And finally—observation indicated that it did develop initiative in the student to some extent.

Acknowledgment

The author is indebted to Dean W. M. Cobleigh and Mr. E. C. Fuller of the Department of Chemical Engineering, Montana State College, for the subject matter of this article.

Mass Warfare on Malaria Waged by Palestine Doctors. Malaria, which scourges whole Arab village populations in certain marshy districts in Palestine, is being subjected to mass attack by a medical corps with headquarters at the Hebrew University located in Jerusalem. The afflicted Arabs, far from being hostile toward their Jewish medical visitors, have been coöperating with them readily in the effort to rid themselves of their perennial ailment.

The first step of the Hebrew University doctors was to find a treatment that could be used effectively in mass treatment of the particular type of malaria prevailing in the district under operation. They found that by combining quinine with plasmochin, one of the newer synthetic quinine derivatives, greater effect on the malaria parasites could be obtained, with less ill effect on the patients. When they had adjusted the dose size by trials with small numbers of individual patients, they were ready for the mass attack.

Two communities of Arabs in marshy regions were selected, one consisting of a group of villages and camps, the other of a single village. Men, women, and children, even babies less than two years old, got their daily two doses of quinine plus plasmochin through five days. About 75 per cent of adults and 85 per cent of all children received the treatment.

Blood examinations disclosed the presence of malaria germs in 28 per cent of the total at the beginning of the period, and in only about 7 per cent at its end—a reduction, therefore, of three-fourths of the infection among those treated.

A discouraging feature of the work is the quickness with which the cured patients become re-infected. New cases of malaria appeared in less than three weeks among the treated persons. Furthermore, other studies have shown that the local Anopheles mosquito is often found more than eight miles away from the nearest breeding places. The final clearing of this malaria-afflicted region will therefore require a long and hard-fought campaign.—*Science Service*

Dangers of Methanol Not Limited to Beverage Use. The danger to health and life of methanol, cheap synthetic wood alcohol which is being widely used as an automobile radiator anti-freeze and in certain industries, is not limited to its use as a beverage, Dr. Carey P. McCord of the Industrial Health Conservancy Laboratories has reported to the American Chemical Society.

The deaths last winter of 208 persons who drank methanol have overshadowed its other dangers, Dr. McCord pointed out, and urged that unusual protective measures for the safety of the public and of industrial workers are needed.

Methanol is now finding wide use in such industries as dry-cleaning, hat-making, metal-working, painting, and cabinet-making.

Methanol is just as dangerous when absorbed through the skin or when its vapor is inhaled as when the liquid is drunk, Dr. McCord found in investigations with animals. Authorities are not generally agreed, however, on the question of whether methanol is dangerous through skin absorption and inhalation.—*Science Service*

AN EXPERIMENT IN SECOND-YEAR COLLEGE CHEMISTRY

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Courses in quantitative analysis often are viewed with disfavor because of their cookbook-like methods, the large amount of time required for laboratory work, and the lack of theoretical training possible with the usual course organization. This paper describes an attempt to eliminate these evils by substituting a course consisting of three lecture periods and one three-hour laboratory period a week, thus making the course, in part, one of introductory physical chemistry. The greater understanding of the principles involved on the part of the students results in greater laboratory accomplishment.

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Introduction

Previous to the school year 1925–26, chemistry majors at the University of Oregon were required to take general chemistry, qualitative and quantitative analysis, organic chemistry, and physical chemistry. With this plan the student mortality in organic chemistry was unusually high and those students who reached the senior year lacked sufficient training in basic principles to undertake a rigorous course in physical chemistry with profit.

The second-year work, analytical chemistry, consisted of the customary one one-hour class period and three (or four) three-hour laboratory periods. This schedule did not provide sufficient opportunity for theoretical training. Attempts to obviate this deficiency have culminated in the substitution of a course called, for want of a better name, second-year chemistry, consisting of three lecture periods and one (or two)* three-hour laboratory periods a week.

That the desirable features of a purely analytical chemistry course can be retained with such a small amount of time devoted to laboratory work has been demonstrated. Although this course is still decidedly in an experimental stage, the apparent local success of the experiment seems to warrant publication of the plans and of the results thus far obtained.

Scope and Outline

Second-year chemistry is now primarily centered about the laboratory procedures which are, in the main, comparable to the laboratory work of the customary course in quantitative analysis. A very close correlation between the classroom and laboratory work is maintained. A fairly comprehensive outline of procedures provides ample opportunity for the

* All chemistry majors enrol for two laboratory periods unless prevented from doing so by schedule difficulties. Most students not majoring in chemistry enrol for only one period.

application of the underlying principles which are thoroughly considered in the classroom. By virtue of the time devoted to class work, these principles can be extended considerably, and the course in effect becomes one of introductory physical chemistry.

For a full exposition of the scope of second-year chemistry, it is necessary to consider briefly its relation to the other courses in the department of chemistry. Freshman chemistry is pre-requisite. This course, too, is undergoing revision and the work of the first two years is developing as a unified sequence.* The first year's work consists of general chemistry and gradually merges into qualitative analysis. Only an abridged scheme of analysis is considered but this seems sufficient to serve as a basis for the quantitative work following. Emphasis is placed throughout upon the equilibrium principles involved. These are ground in so thoroughly that they constitute a strong foundation for the quantitative considerations of equilibrium in the second year.

In the third year, in addition to organic chemistry, most of the chemistry majors enrol for an additional course in analytical chemistry, in which a larger proportion of time is devoted to laboratory work. This course includes a rigorous completion of qualitative analysis, and an extension of quantitative analysis to more complicated procedures. Some interesting departures are being made in this course also and will be made the subject of a later paper.

The laboratory work of second-year chemistry is grouped about three reaction types, namely, neutralization, precipitation, and oxidation-reduction. Approximately one term (ten weeks exclusive of examinations and enrolment) is devoted to each type. An outline of the experiments performed will best illustrate both the amount and complexity of laboratory performance which has been found possible under this plan. For the sake of brevity only the work pursued by a student enrolled for one laboratory afternoon a week or a total of about thirty three-hour laboratory periods is given. This is important if a comparison is made with the usual course in quantitative analysis. Students registered for two laboratory periods undertake approximately twice as many laboratory procedures. Accompanying the laboratory outline is presented a brief statement of the work taken up in the classroom. It will easily be recognized that there is considerable opportunity for freedom in this phase of the work, and that any written outline must necessarily be inadequate. The class work of the first term is presented in more detail than the rest to indicate roughly the intensity of the work.

* In developing the present course of second-year chemistry the author wishes to acknowledge his indebtedness to the other members of the staff and especially to Professor O. F. Stafford, chairman of the department staff, and the professor giving the work in freshman chemistry, for their sympathetic attitude and helpful suggestions.

Outline of Course

FALL TERM

Laboratory

1. Use and care of analytical balance.

While checking equipment and preparing the solutions for the following project, small groups are taught to use the balance properly under the supervision of a laboratory assistant. Only the better students are encouraged to use the sensitivity method at this time.

2. Volume ratio, acid-base.

Individual solutions of approximately 0.5 *N* NaOH and HCl are prepared and used from bottles equipped with delivery tubes. Either methyl orange or methyl red is used for the indicator.

3. Standardization of acid with sodium carbonate.

Only a few students choose to prepare their standard from the bicarbonate.

4. Determination of normality of alkali. (Unknown)

This serves as a check on the standardization.

5. Alkalinity of soda ash. (Unknown)

An excess of standard acid is used and the excess titrated with standard alkali after boiling.

6. Determination of oxalic acid. (Unknown)

Before performing this experiment, facility with the use of phenolphthalein is attained by redetermining the acid-base volume ratio.

7. Indicators.

This is a semi-quantitative experiment involving the titration of sodium carbonate, sodium bicarbonate, sodium hydroxide, and phosphoric acid using several indicators. Some buffer solutions are also introduced.

Class Work

1. Chemical arithmetic.
   - *a.* Chemical factors.
   - *b.* Volume ratios and titers.
   - *c.* Normal, molar, and molal solutions, specific gravity and percentage compositions.
2. Energy.
   - *a.* System defined.
   - *b.* Types of energy and relation to work.
   - *c.* Law of conservation of energy.
3. Gases and the kinetic theory.
   - *a.* The gas laws of Boyle, Charles, Dalton, Graham, and Avogadro
   - *b.* Numerical significance of gas constant.
   - *c.* Mathematical proof of kinetic theory.
   - *d.* Mol fractions.
   - *e.* Abnormal gases.
4. Solutions.
   - *a.* Concentrations.
   - *b.* Perfect solutions.
   - *c.* Colligative properties.
   - *d.* Raoult's law and molecular weights.
5. Speed of reactions and equilibrium constants.

6. Theory of ionization and application of theory.
7. Neutralization and hydrolysis.
8. Hydrogen-ion concentration and pH.
9. Indicators and buffer solutions.

WINTER TERM

Laboratory

1. Gravimetric determination of chlorine. (Unknown)
The Gooch method is used. The unknowns are mixtures of NaCl and KCl. Some students restandardize their HCl first, usually using the paper method.
2. Solubility.
This is an experiment dealing with the formation and solution of precipitates. The solubility product principles are emphasized in the written report. This experiment is easily performed simultaneously with other work.
3. Gravimetric determination of iron. (Unknown)
The unknown consists of Mohr's salt and potassium sulfate. The ferric hydroxide is precipitated twice.
4. Gravimetric determination of sulfate. (Unknown)
The filtrate from the ferric hydroxide precipitation contains the sulfate for this experiment.
5. Standardization of silver nitrate solution.
The Mohr method is used.
6. Volumetric determination of chlorine. (Unknown)
Most students again use the Mohr method but some substitute the Volhard method.

Class Work

1. Ion product constant principles.
2. The colloidal state.
3. Fractional precipitation.
4. The liquid state.
5. Vaporization of liquids.
6. Systems of two volatile components.
7. Solutions of gases in liquids.
8. Atomic structure and the periodic system.

SPRING TERM

Laboratory

1. Standardization of potassium permanganate with sodium oxalate.
Some students standardize with iron wire instead of, or in addition to, the oxalate method.
2. Volumetric determination of iron. (Unknown)
Any ferric iron is reduced to ferrous with stannous chloride. Preventive solution is added before titrating.
3. Volumetric determination of calcium oxide. (Unknown)
The calcium is precipitated as oxalate, dissolved, and titrated with permanganate.
4. Standardization of sodium thiosulfate solution.

Either the potassium permanganate previously standardized, or some primary standard such as bromate or iodate is used.

5. Determination of normality of iodine solution. (Unknown)
6. Iodimetric determination of copper. (Unknown)
7. Choice of several experiments such as analysis of Paris Green, pyrolusite, hydrogen peroxide, etc.

Class Work

1. Significance of oxidation-reduction.
2. Balancing oxidation-reduction equations.
3. Electrode potentials and the electromotive series.
4. Faraday's laws.
5. Electrolysis and electroplating.
6. Galvanic and storage cells.
7. Thermochemistry.
8. General review.

Discussion

The above outline of laboratory work is quite easily covered in the allotted time by the better students. The poorer students usually prolong each laboratory period somewhat. The ability of the students to complete this amount of laboratory work in thirty laboratory periods is attributed to a greater understanding on their part of the principles involved, thus eliminating the usual cookbook fashion of blindly following a set of directions.

The laboratory "plan" system, carried over from the work of the freshman year is another important contribution to the understanding of the work undertaken. These plans, written up in advance by the student, vary from a concise report of the procedure involved and its accompanying theory during the first part of the year to original methods of attack during the latter part. These plans are carefully checked over with the student before he starts his laboratory work. When the work is completed the final report is written on the same card and is then graded. Frequently, a pre-laboratory discussion of these plans is held.

The students take advantage of the opportunity for getting help from the laboratory assistants on drill assignments during the laboratory hours.

By issuing carefully analyzed unknowns for analysis, a check is readily obtained on the technic developed under the system in use. In general, duplicates varying not more than two parts per thousand are required. Usually over half of the students obtain results whose average varies by less than four parts per thousand from the accepted value and many more exceed this but slightly.

Summary

In this article has been described a successful attempt to substitute in part a course of introductory physical chemistry for the usual course of

analytical chemistry without losing the advantages of the latter. This has been accomplished by changing to a schedule consisting of three one-hour class periods and one (or two) three-hour laboratory periods a week. The greater emphasis on the theoretical side thus makes possible a more thorough understanding of the laboratory work pursued which is reflected in greater laboratory accomplishment.

Coolant Is Sealed in New Airplane Motor without Radiator. Aviation engineers have found that they may be able to fill the radiator of their motor, screw down the cap and seal it permanently with nuts and bolts, and fly away, never to be bothered with adding more liquid or with engine cooling troubles.

This, in effect, is what has been done by engineers at Madison, Wis., as a continuation of research started by the Army and the Navy. In a paper presented before the aeronautic meeting in Cleveland of the Society of Automotive Engineers, J. H. Geisse, Vice President of the Comet Engine Company, described the development of a liquid-cooled airplane engine which has no radiator.

To be sure, the liquid is there and it circulates around the cylinders, but when heated it is not run through a separate set of coils and fins set boldly in the air stream to get greatest cooling effect. There is no such radiator to increase the wind resistance of the plane. The coolant merely circulates within itself, the hot liquid rising and the cool falling, and gives off through the engine casing and through external fins, the heat absorbed from the cylinder walls.

This decrease in wind resistance and reduction of engine weight is made possible by the use of ethylene glycol in place of water. Ethylene glycol has been the subject of considerable research in the past. It boils at 385 degrees Fahrenheit, instead of 212 degrees as does water, and, having a higher specific heat, conducts heat away from the hot cylinders faster than water.

Mr. Geisse said that the new coolant makes it possible for engineers to build satisfactory radiators just half as large as those cooled by water.—*Science Service*

Hafnium. The radio industry has shown interest in the rare metal hafnium, which was discovered only eight years ago. Already several patents have been taken out for its use. High electron emissivity combined with high melting point (over 2200°C.) fit it for use in filaments, and for the cathode surfaces of X-ray tubes and rectifiers. The pure metal is soft and pliable, like copper, and about 50% heavier.

According to U. S. Bureau of Mines Information Circular No. 6457, it is one of the most abundant of the rare elements, yet hardly destined ever to become cheap. At the present time its ores can be bought for about $32 per pound of contained hafnium. These ores are to be found in scattered small deposits, several interesting ones being at Cape Ann, Massachusetts, Henderson County, North Carolina, and Kragerö, Norway. The refining cost is very high, due to the difficulty of separating it from its sister element, zirconium, so that compounds such as the chloride and oxide can still be purchased in small amounts only, even at $10,000 per pound. The richest ores are altered zircon, the hafnium-containing deposits of which are frequently prospected with electroscope or photographic plate, taking advantage of the usual contamination by radioactive material.—*Industrial Bulletin of Arthur D. Little, Inc.*

THE SECOND LAW AND ENTROPY

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The viewpoint is taken that in a first course in chemical thermodynamics, the second law should be a fundamental postulate, and that the approach to the thermodynamic functions should be physical. The second law is expressed in the form, heat cannot be converted into work without compensation; and with this as a fundamental postulate, a method is given for the development of the concept of entropy.

. . . . . .

In a recent paper, Hazlehurst (*1*), speaking of entropy says, "It is bound up in some obscure way with an equally mysterious second law, which has the reputation of saying a great deal but which is actually as meaningless to the tyro as a magic alchemical recipe." That such a vagueness exists in the mind of the student of thermodynamics as to the meaning of the second law, is due, in the present writer's opinion, to the student's inability to interpret the natural processes which are a part of his every-day experiences. For this reason, the writer feels that in a first course in chemical thermodynamics, the second law should be made a fundamental postulate and that the approach to the thermodynamic functions should be *physical.* If a fundamental statement of the second law is given, it is quite possible to have this physical approach, for example, to the concept of entropy without sacrificing entirely the elegance of a purely mathematical treatment.

Tolman (*2*) says: "Moreover, the truth of the two fundamental laws, at least as far as the macroscopic behavior of physical-chemical systems is concerned, can hardly be questioned; deviations from the laws have never been found..... We must regard the theorems of thermodynamics as among the most certain possessions of science."

Surely, in the light of these facts we are justified in taking the second law as one of the fundamental laws of chemical thermodynamics. The present paper will be limited to the physical approach, through the second law to the thermodynamic function known as entropy.

The most useful statement of the second law is, heat cannot be converted into work *without compensation.* It is in this respect that heat energy differs from mechanical energy. There are two possible cases to be considered both of which have come within the student's experience. The first case is that in which heat is converted into work at constant temperature, that is, an isothermal process by which heat is converted into work. What is the compensation? A few examples of such processes as the isothermal expansion of a compressed gas, the isothermal evaporation of a liquid at its boiling point, and the isothermal production of electricity in a voltaic cell show at once that an isothermal process can convert heat into work only if that isothermal process be accompanied by a *change in state.* The change in the state is the compensation. This

experimental fact enables us to draw several deductions; for example, an isothermal cycle obviously cannot convert heat into work. A cycle involves no change in state. Perpetual motion obtained from an isothermal cycle has been called "perpetual motion of the second kind." We see therefore, that "perpetual motion of the second kind is impossible."

From the impossibility of perpetual motion of the second kind arises the concept of a reversible *isothermal* process. The isothermal expansion of a perfect gas from state A to state B can be carried out in such a way that a definite maximum amount of work can be obtained from it, at the expense of the heat of the surroundings. Since work cannot be obtained from heat by an isothermal cycle, it will require as a minimum of work, to restore the gas from state B to state A, a quantity of work equal to the maximum obtained by the direct process. In the reverse process an equivalent quantity of heat will be given to the surroundings. We can define, therefore. an isothermal reversible process as one in which the maximum amount of work is obtained or the minimum amount of work is expended.

The usual analysis can then be used to show that the criterion of a reversible process is not only that the work of the process is the maximum possible, but also that an infinitesimal change in the force against which the system is acting will actually cause the process to take place in the reverse direction. The reversible process consists of a series of equilibrium states infinitely close together, and when the process is *reversed* the system goes through the same series of equilibrium states but in the reverse direction. It becomes obvious, then, that a reversible process does not have to be, necessarily, isothermal.

The second possible case by which heat energy is converted into work is seen to be a cyclic process, and such a cyclic process cannot be an isothermal one. What then is the compensation?

Experience shows us that in this case always a certain quantity of heat must be absorbed from a "source" at a given temperature, that a *part* of this heat can be converted into work, but the remainder must be rejected to a "sink" at a lower temperature. This rejection at the lower temperature of a part of the heat taken up at the higher is the compensation in this case.

If the quantity of heat Q_{1-} be absorbed from a source at the temperature T_1, by the heat engine, then a quantity of heat Q_{2+} must be rejected to a sink at a lower temperature T_2, the quantity $Q_{1-} - Q_{2+}$ being converted into the work $W+$.

The efficiency of the reversible cyclic process can then be obtained in the usual way. The expression obtained is

$$\frac{Q_{1-} - Q_{2+}}{Q_{1-}} = \frac{T_1 - T_2}{T_1} \tag{1}$$

or

$$\frac{W_+}{Q_{1-}} = \frac{T_1 - T_2}{T_1} \tag{2}$$

If $T_1 = T_2$, $W_+ = 0$, which is in harmony with the conclusion already drawn. Equation (1) may be put in the form,

$$\frac{Q_{1-}}{T_1} - \frac{Q_{2+}}{T_2} = 0 \tag{3}$$

and if we write Q_1- for the quantity of heat absorbed at T_1, and Q_2- for the quantity of heat absorbed at T_2, we have finally,

$$\frac{Q_{1-}}{T_1} + \frac{Q_{2-}}{T_2} = 0 \tag{4}$$

Without difficulty, we can extend our treatment to any reversible cycle. We imagine that at various stages of a reversible cycle, the heat elements δq_1, δq_2, $\ldots \delta q_n$ are absorbed from reservoirs at the temperatures T_1, T_2, $\ldots T_n$, and the heat elements $\delta q_1'$, $\delta q_2'$, $\ldots \delta q_n'$ are rejected at the temperatures T_1', T_2', $\ldots T_n'$. We have in addition a source at a temperature T, where $T > T_1, T_2 \ldots T_n$ and a sink at a temperature T' where $T' < T_1'$, T_2', $\ldots T_n'$.

When the cycle has been completed the reservoir at T_1 has lost the heat element δq_1. We can restore this quantity of heat to the reservoir at T_1, by a reversible cycle operating between the temperatures T and T_1. If the reservoir at T_1 gains the heat δq_1, the source loses the heat X_{1-} and

$$\frac{X_{1-}}{T} = \frac{\delta q_1}{T_1} \text{ or } X_{1-} = T\frac{\delta q_1}{T_1}$$

Similarly, it can be shown that

$$X_{2-} = T\frac{\delta q_2}{T_2}$$
$$\equiv\equiv\equiv\equiv\equiv\equiv\equiv\equiv$$
$$X_{n-} = T\frac{\delta q_n}{T_n}$$

The source at T loses in all the heat quantity $Q-$.

$$Q_- = X_{1-} + X_{2-} + \ldots + X_{n-} = T\left[\frac{\delta q_1}{T_1} + \frac{\delta q_2}{T_2} + \ldots + \frac{\delta q_n}{T_n}\right]$$

Similarly the gains $\delta q_1'$, $\delta q_2'$, $\ldots \delta q_n'$ of the reservoirs at T_1', T_2', $\ldots T_n'$ can be used in reversible cycles between the respective temperatures T_1', T_2', $\ldots$ and T'. The sink at T' gains, in all, the heat quantity Q_+.

$$Q_+ = X_{1+}' + X_{2+}' + \ldots + X_{n+}' = T'\left[\frac{\delta q_1'}{T_1'} + \frac{\delta q_2'}{T_2'} + \ldots + \frac{\delta q_n'}{T_n'}\right]$$

The original cycle with all its stages is equivalent to a reversible cycle in which the quantity of heat Q_- is absorbed by the work mechanism from

the source at T, and the quantity of heat Q_+ is rejected by the mechanism to the sink at T'.

Hence from (3) and (4) we have

$$\sum_{1}^{m} \frac{\delta q_r}{T_r} = 0, \quad m = 2_n \tag{5}$$

As $m \longrightarrow \infty$ and $\delta q \longrightarrow DQ$, equation (5) becomes

$$\oint \frac{DQ}{T} = 0 \tag{6}$$

DQ is an inexact differential which for a reversible path of change in state is given by the first law equation for such a path,

$$DQ = dE + pdV \tag{7}$$

Since

$$\oint \frac{DQ}{T} = 0, \quad \int_A^B \frac{DQ}{T}$$

is a line integral which is independent of the path which connects the points A and B. Otherwise expressed, $\frac{DQ}{T}$ is an *exact* differential of some function S of the variables which determine the state of the system. In this respect S is in the same class with the other thermodynamic functions U, A, H, F and is seen to be as much a property of a given body or system as is the familiar physical quantity V. S is the property of the body or system that is known as its entropy. For some entirely unknown reason, the student "shies" at S, but endures F (the free energy function) and embraces V.

The interesting fact has arisen in our treatment that although DQ is an inexact differential, $\frac{DQ}{T}$ is exact and equal to dS.

If we take, therefore, the equation

$$DQ = TdS \tag{8}$$

as the expression for the second law (for a reversible path) we can combine the two laws, for a system of constant mass, in a single equation,

$$dE = TdS - pdV \tag{9}$$

where all the differentials are exact.

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ZERO COLD TEST

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The increasing use of the automobile in winter months, especially in regions where winter temperatures are very low, has resulted in a demand for lubricating oils possessing special properties adapting them to use in such regions.

The petroleum refiners, in increasing numbers and with a large measure of success, have met this demand by putting on the market lubricating oils whose characteristics are adapted to winter driving.

The following may be considered to be the most important desirable characteristics of lubricating oils. The first four properties listed are of particular importance with respect to oils intended for winter use.

Desirable Characteristics of Lubricating Oils

1. Low cold test.
2. Should not solidify under conditions of use.
3. Should not greatly change viscosity under conditions of use.
4. Should have good viscosity at all engine temperatures.
   a. Should remain fluid in coldest weather.
   b. Should have some degree of viscosity up to 250°F.
5. High flash and fire tests.
   a. Oil is thus indicated to be unlikely to take fire and also indicated not to be a blend of light with heavy oils to regulate viscosity.
6. Low carbon residue.
7. Low acid number.
8. Low sulfur content.
9. Low Maumenè number.
10. No corrosive action on metal surfaces.
11. Minimum amount of gum formation.
12. Slow rate of evaporation.
13. High mechanical efficiency.

It will perhaps be of interest to the motor-car driver, who must select the lubricating oil he is to use from the large number of brands whose merits are presented to him in such technical terms as "cold test," "viscosity," etc., to know the exact meaning of these terms, their significance, and something about the methods used to produce lubricating oils having those desirable characteristics for winter driving which were previously listed.

Cold Test

The cold test of a lubricating oil is that temperature at which the oil will no longer flow. This temperature is determined in the following way.

A sample of the oil to be tested is placed in the test cylinder which is equipped with a cork and a special thermometer. The cylinder is then immersed in a cooling medium and the temperature of the oil sample thus gradually reduced.

At each cold test thermometer reading which is a multiple of 5°F., the cold test jar shall be removed from the jacket carefully and shall be tilted just sufficiently to ascertain whether the oil around the thermometer remains liquid. As long as the oil around the thermometer flows when the jar is tilted slightly, the cold test jar shall be replaced in the jacket. The complete operation of removal and replacement shall require not more than three seconds. As soon as the oil around the thermometer does not flow when the jar is tilted slightly, the cold test jar shall be held in a horizontal position for exactly five seconds, and observed carefully. If the oil around the thermometer shows any movement under these conditions, the cold test jar shall be immediately replaced in the jacket and the same procedure shall be repeated at the next temperature reading 5°F. lower. As soon as a temperature is reached at which the oil around the thermometer shows no movement when the cold test jar is held in a horizontal position for exactly five seconds, the test shall be stopped and this temperature reported as the cold test.

Viscosity

The resistance experienced by one portion of a liquid in moving over another portion is called viscosity. The term is also defined as "resistance to flow" and internal friction. The extent to which an oil substitutes its own smaller internal friction for the friction of metal surfaces is largely dependent upon its ability to maintain an easily deformable film of oil on these metal surfaces. In general, the power to adhere to metals increases with the viscosity of the oil. The viscosity that an oil should have is dependent on the intended use of the oil. Low pressure and high speeds require the use of a very mobile oil. The use of a highly viscous oil in such a case would mean a large power loss. High pressures and lower velocities require the use of a more viscous oil. The use of a mobile oil in such cases would mean a waste of lubricant. Since the viscosity decreases with increasing temperatures it is common practice to determine viscosities at several temperatures. The viscosity is reported as the number of seconds time required for a standard sample to flow from a small orifice at a definite temperature.

It is to be noted that an oil should not be selected merely on the basis of a low cold test at the expense of desirable viscosity characteristics. Poorly refined oils may have low cold tests but will show an excessive drop in viscosity with increasing motor temperatures, which means poor lubrication at higher motor temperatures.

Other Properties

The flash point of an oil is the lowest temperature of the heated oil at which the vapors arising from it will ignite with a flash of short duration when a flame is brought near the surface of the heated sample.

The *burning point* of an oil is the lowest temperature of the heated oil at which the vapor arising from it will ignite and continue to burn with a steady flame when a flame is brought near the surface of the heated sample.

The carbon residue is the percentage of carbon remaining as residue when a 10-gram sample of the oil is burned as described in the Conradson Carbon Residue Test.

The acid number of a lubricating oil is the number of milligrams of potassium hydroxide necessary to neutralize one gram of the oil. In many cases high acidity of a lubricating oil will cause corrosion of journals and bearings; consequently, first-class lubricants should be relatively free of acid.

The sulfur content of an oil is the percentage of total sulfur present. Since a considerable proportion of this sulfur may be present in the form of corrosive acids, or substances easily converted to corrosive acids, a good lubricant should have a low sulfur content.

The Maumenè number is the number of degrees Centigrade rise in temperature occurring when 10 cc. of concentrated sulfuric acid is added to 50 grams of oil. The significance of this number lies in the fact that the Maumenè number of an oil compounded with animal or vegetable oil will be higher than for the pure mineral oil.

The extent to which an oil substitutes its own smaller internal friction for the friction between the surfaces to be lubricated is a measure of its mechanical efficiency. The mechanical efficiency depends largely on viscosity and, to a lesser extent, on various other properties and is consequently determined largely by these properties.

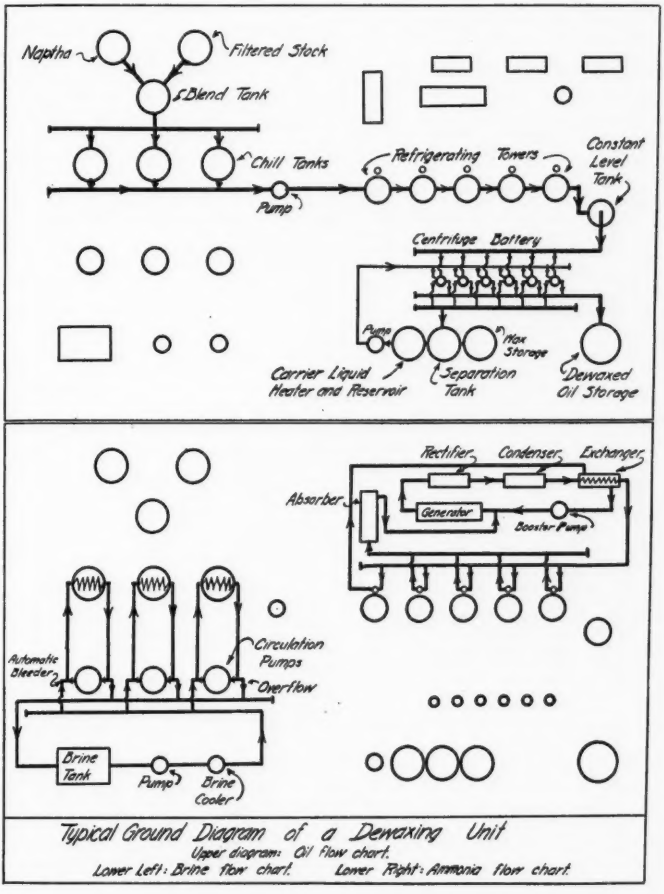
De-waxing

The problem of producing lubricating oils having desirable characteristics for winter driving has been found to be largely one of removing from the oil in the refining process those substances which form solids or semi-solids at low temperatures, notably the paraffin wax which remains in solution in the oil at moderate temperatures, but which crystallizes out at lower temperatures.

The removal of a certain amount of the paraffin wax content of lubricating oils has for some time been a common refinery practice. A more complete removal of the wax has become necessary to produce oils suited to winter driving and this has been accomplished by improvements in the process, notably by the introduction of the centrifuge and operation of the process at lower temperatures.

A description of a de-waxing process capable of producing lubricating oils suited to winter driving in the coldest regions follows. The process employs Sharples centrifuges and operates at temperatures lower than those generally used until recently.

The filtered lubricating oil stock and the naphtha with which it is to be



Typical Ground Diagram of a Dewaxing Unit

Upper diagram: Oil flow chart.

Lower Left: Brine flow chart. Lower Right: Ammonia flow chart.

mixed are pumped from their respective storage tanks to a blending tank where they are mixed in the ratio of 60% of naphtha to 40% of stock. If the oil were not diluted with naphtha it would become so viscous on cooling that it could not be readily pumped. This mixture is heated to 100°F., and then is cooled in the chilling tanks to temperatures ranging

from minus 10°F. to minus 18°F., during a period of 48 hours. These tanks are provided with mechanical stirrers by means of which the contents are agitated from time to time to insure complete solution of the oil in the naphtha. The chilling of the oil in these tanks is accomplished by circulation of brine.

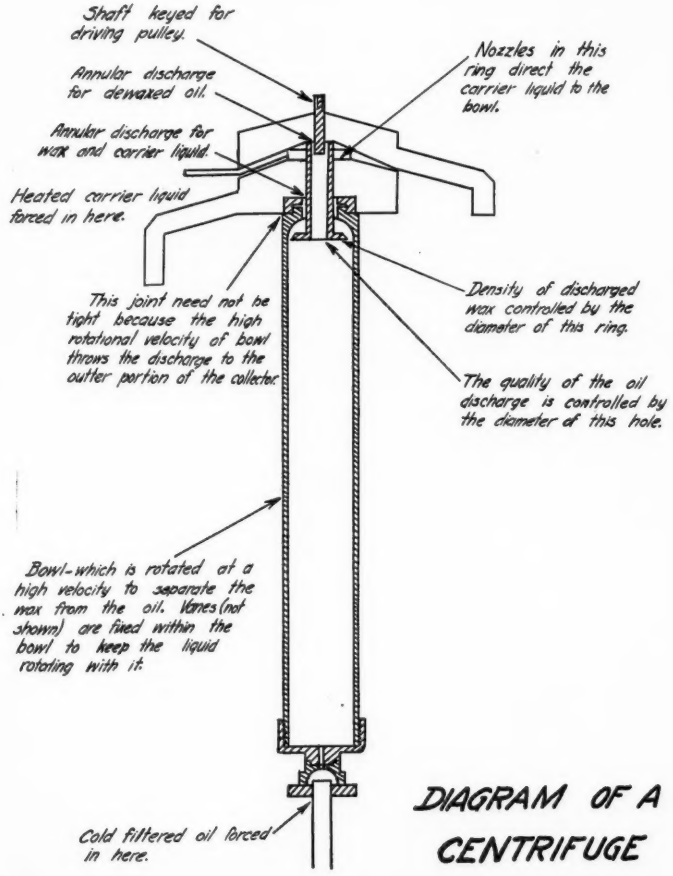

Shaft keyed for driving pulley.
Annular discharge for dewaxed oil.
Annular discharge for wax and carrier liquid.
Heated carrier liquid forced in here.
Nozzles in this ring direct the carrier liquid to the bowl.
This joint need not be tight because the high rotational velocity of bowl throws the discharge to the outter portion of the collector.
Density of discharged wax controlled by the diameter of this ring.
The quality of the oil discharge is controlled by the diameter of this hole.
Bowl-which is rotated at a high velocity to separate the wax from the oil. Vanes (not shown) are fixed within the bowl to keep the liquid rotating with it.
Cold filtered oil forced in here.

DIAGRAM OF A CENTRIFUGE

Better operation on the refrigerating machine and better control on the individual chilling tanks can be obtained by the use of two brine circuits. The first circulates from the brine tank to the brine cooler and then at about minus 20°F. to each of the tank circuits. Here cold brine is taken into each tank circuit as required and the balance returns to the brine tank.

The second circuit operates in parallel, brine being circulated through the coils of each chilling tank independently. The temperature control is obtained by admission of cold brine from the main circuit as required. This admission displaces an equal amount of brine in the secondary circuit which overflows into the brine tank and hence into the main brine circuit.

After being chilled to temperatures ranging from minus 10°F. to minus 18°F. in the brine tanks, the solution of the oil in naphtha is pumped through a series of chillers maintained at increasingly lower temperatures by means of direct ammonia expansion. The temperature of the solution as it leaves this series of chillers ranges from minus 38°F. to as low as minus 50°F. Chilling of the solution to this temperature range requires chilling medium temperatures of from minus 50 to minus 60°F. and these chilling medium temperatures are best obtained by ammonia expansion.

The solution now is pumped to a constant level tank where, by means of float control, a constant head is maintained on the centrifuges to which the stock flows from the constant level tank.

The Sharples centrifuges used to remove the wax operate continuously, the chilled solution being fed in at the bottom of the centrifuge and the wax and oil from which it has been separated discharging separately. The actual separation of wax from oil is accomplished by means of centrifugal force.

As the solution is fed into the rapidly revolving bowl of the machine (17,000 r. p. m.) the amorphous wax, being heavier than the oil solution, is thrown to the outside where it forms a layer. Water at a temperature of 145°F. is jetted into the top of the bowl at the point of wax discharge and is carried in part into the bowl forming a thin layer of liquid next to the bowl shell. This water keeps the wax from becoming solid and makes possible the continuous upward flow and subsequent discharge of this mixture at the top of the bowl.

Next to the wax layer but nearer the center of the bowl is formed a layer of bright wax-free oil. Separation of the two layers at the top of the bowl is accomplished by annular discharge rings which can be adjusted to obtain desired thickness of layers of wax, oil, and water.

The mixing of warm water (145°F.) with the discharging wax at the top of the bowl keeps the discharging wax in a free-flowing condition. From the centrifuge this mixture of wax and water flows to a tank where the wax and water are separated by gravity, the wax flowing to one compartment from which it is pumped to storage and the water to another compartment where it is kept warm and re-used in the centrifuge.

The Sharples centrifuges will de-wax from 55 to 65 barrels of the oil-naphtha solution in a 24-hour period, producing from 900 to 1150 gallons of de-waxed oil, depending on the desired specifications. Power required is 1 kw. hour per unit and refrigeration 6.5 tons per 24 hours per unit.

DRAWING REPRODUCTION AND LANTERN SLIDE MAKING

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The use of Kodalith paper will enable one to make easily, excellent reproductions of graphs, line drawings, or even tabulated data by direct contact. This paper also can be used to prepare lantern slides of remarkable clarity and contrast.

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When several copies of a drawing or graph are necessary for a thesis or manuscript it is a time-consuming chore to have to reproduce them by hand, and they are seldom all identical. Many lectures or presentations of papers could be greatly improved by tabulating the data or by the use of a graphical method if lantern slides were less expensive or could be made more easily. Resort must be had to photographic methods which are sometimes considered as complicated or unsatisfactory in any but the hands of an expert.

The most difficult part of the procedure is to obtain clear-cut black lines on a perfectly white background. Home-made slides of graphs usually have a fogged or blurry background which does not give the contrast necessary for good projection on a screen.

A printing paper or film which has great contrast is required, and yet none of the usual contrast papers are quite good enough for this purpose in amateur hands. It was suggested that Kodalith, a new Eastman paper which has extreme contrast (in fact it is useless for making positives of "picture" negatives), might be used successfully for our purpose. Kodalith was originated for printers and lithographers for reproduction of pen and ink drawings in which extremes of black and white are necessary. The paper of which Kodalith is made is quite textureless and is used in making either positives or negatives. We have used Kodalith paper in place of film in a film holder, with marked success, in the reproduction of graphs by direct contact, and in the preparation of lantern slides, and felt that others would be interested in this simple method of obtaining excellent results.

Contact Reproductions

The first attempt made was to prepare negatives of Kodalith directly from a drawing on graph paper. It was found that the paper on which these graphs are printed is not sufficiently textureless to give the best results. So the graphs were drawn on tracing cloth and a negative prepared on Kodalith. These reproductions were to be ordinary manuscript size, 11 × 8.5, and it was found most economical to purchase Kodalith 11 × 14 and cut it to 8.5 inches. The remaining strip was 11 × 5.5 and was used later in making lantern slides. Instead of attempting to center and square the negative paper and tracing cloth exactly, the full size (11 × 14) was

used in making the negatives and this was then cut to size with the graph placed in the exact position thought best. No printing frame of this size was available, so a box about 10 × 14 × 17 was covered with a flashed opal glass, and a 60-watt bulb was placed in the bottom. The base of the light was ten inches from the top glass and the Inside was painted with aluminum paint. A board around which six thicknesses of blanket were tightly wrapped and fastened was used to hold the paper and tracing cloth in place. The exposure is one second for India ink drawings on tracing cloth, and from 2 to 3 seconds for the positives of negatives so obtained. The exposure should be such that on development the image begins to appear in one-half minute and the development is complete in two minutes. This certainly gives the best results although it has been found possible to vary the time of exposure somewhat and yet obtain excellent negatives. The negatives are developed, using a yellow filter (Wratten Safelight Series 00) which is almost as bright as ordinary light. Of course, for the lantern slides themselves a red Wratten Safelight Series 2 must be used. They are rinsed, fixed, and washed in the usual manner. The developer used was Formula D-85 which is given on the slip of directions accompanying the Kodalith paper. The developer can be used until it takes on a light brown color; after that the developing time is increased and the prints are liable to stain.

After the washing it makes the paper slightly more flexible to soak in 10% glycerin solution for a few minutes. The paper will be less curled, if a ferrotype is available for drying. The drying can be markedly speeded up by placing an electric toaster in front of an electric fan and by this combination blowing hot air over the prints on the ferrotype. If the exposure and development have been correct the negative will consist of a dense black background, so dense that a 100-watt lamp will not shine through, and of perfectly clear lines. There is no shading at all.

The negative is now trimmed so that its size is 11 × 8.5 with the drawing or graph in the exact position required. A piece of Kodalith cut to the same size is placed, emulsions together, with the negative and another exposure of from 2 to 3 seconds made. To avoid a thin black margin it is advisable to prepare a border of black paper which can be pasted to the glass and which should be about $1/4$ to $1/2$ inch less than the dimensions of the finished print. This is then treated in exactly the same way as the negative. It is possible to expose all the necessary positives and then develop them three or four at a time.

When properly done, and the technic is not at all difficult to acquire, the result is a perfect copy of the original drawing with intense black lines on a pure white background. In fact so great is the contrast that slight imperfections, light pencil lines, etc., need not be removed. They do not appear in the final copy.

Lantern Slide Preparation

The extremes of black and white obtained suggested that a lantern slide prepared from it, even using Eastman lantern slides, Slow, would have marked contrast. Such is the case. However, instead of drawing the graph or sketch on lantern slide scale, it is preferable to make drawings about 11 × 8.5 and reduce them by using a camera. If graphs are drawn in India ink on graph paper, these may be photographed directly; the blue printed coördinates do not show up at all on the final slide. This is a great advantage, as usually the fine lines are not desired on the slide; however, the important coördinates must be drawn in.

If a sketch is made lightly in pencil it may be run over with India ink and photographed on Kodalith paper without removing the pencil marks. Lantern slides of tabulated data can be made excellently and conveniently by photographing typewritten tables made heavily with a new ribbon.

In each case a piece of Kodalith paper was cut to fit a film holder and, after focusing the camera, was exposed for a time best determined by experiment. This is almost always required even when using films or plates, so that the lesser cost of Kodalith is another point in its favor. The time of exposure is dependent on the speed of the lens, on the stop used, the reduction in size of the image and the intensity of the illumination. Some examples which we have found successful may be helpful.

For illumination, a 500-watt lamp in a Kodalight reflector, covered with ordinary tracing cloth to give a diffused light was placed on each side of the camera and about two feet distant from the object. The drawing or typewritten data was held on a drawing board under glass by clamps. The iris diaphragm on the lens was opened and the drawing focused as accurately as possible, and the iris closed somewhat to increase the sharpness of the image. Closing the diaphragm lengthens the exposure necessary but it is frequently worthwhile. In one instance a half-tone was being converted into a lantern slide. When completed, the screen marks were perfectly clear cut on the slide and were obvious to those sitting near when the image was projected. With the above set-up an 11 × 8.5 drawing cut down to an image of 4.25 × 3.25 (slide size) and a stop of 16, the best exposure was 2.5 minutes, using either a 5 × 8 Tessar 1c or 4 × 5 Tessar 11b lens. Doubling or halving this exposure does not particularly spoil the result. A small over-exposure can be compensated by underdevelopment and vice versa but this is not to be recommended for the very best results. For instance, a diagram from the pages of a book was converted to a lantern slide using the 5 × 8 Tessar 1c lens at stop 8, a 40-second exposure required two minutes for development and the result was excellent, a 20-second exposure required two and a half minutes development, and an 80-second exposure required 100 seconds development. The

last two negatives were quite usable but not as nearly perfect as the first.

After treating in the manner previously described the paper negatives can be turned into positives, using Eastman Slow lantern slides. Because of the marked opacity of background the exposure of the plate can be rather widely varied without changing the final product. From one-half to two seconds is about right. The subsequent treatment of the plates is described by the manufacturer in a slip in each package. Lantern slides made in this way have a clear background and dense black lines.

Claims Coal Will Be Basic Fuel for Centuries. Although increasing use is being found for oil and natural gas as fuels, we shall continue to burn more coal than anything else; and when all the oil and gas are exhausted we shall still be burning coal.

For after using coal for nearly three centuries the United States has consumed only one per cent of its supply, and if this country continues to use coal at the average rate of the past ten years, the known deposits will last about 4000 years.

Coal will continue to be the basic fuel because it is cheap, widely distributed, and is abundant, it is claimed in a report made recently before the American Society of Mechanical Engineers by Henry Kreisinger, combustion engineer of New York City. Mr. Kreisinger declared that prices of oil and natural gas depend largely on the cost of coal.

"Coal," he said, "can be produced at an average cost of one dollar per net ton. It can be delivered in large quantities to steam plants at an average of $3.50 per net ton. Assuming the average heat value of coal to be 12,500 British thermal units as received, the average cost per million B. t. u. at steam plants is 14 cents."

Oil, it was pointed out, has an average heat value of about 18,500 British thermal units per pound. On the basis of heat cost of 14 cents per British thermal unit, a barrel of 336 pounds of fuel oil would cost only 87 cents.

On the same basic cost per million British thermal units, natural gas having a heat value of 1000 B. t. u. would sell at 14 cents per 1000 cubic feet, Mr. Kreisinger said. —*Science Service*

Drought Did Not Change Chemistry of Soil. Farmers who believe that last year's drought affected soil chemically to improve it for this year's crops are mistaken, according to J. B. Kincer of the Weather Bureau.

"Abnormal crop growth this year is due entirely to contemporary weather conditions, "he said, "and in no way may be attributed to improvement of soil conditions."

The summer, particularly the month of July, has been unusually warm, and rainfall has been above normal in Atlantic seaboard and southern states, it was explained. Under such conditions, all vegetable matter grows rapidly.

The fact that disproves the theory that the soil is chemically changed may be brought out by comparing eastern and southern state crop conditions to those in the corn belt, through the north and northwest. In the corn belt last year's drought was just as severe as in the east, yet subnormal rainfall has caused this year's crops to be below normal.

Plenty of heat, coupled with constant moisture due to opportune rainfall, are the causes for abnormal crop growth.—*Science Service*

LANTERN SLIDES FROM CELLOPHANE

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Methods of making lantern slides from cellophane or from cellulose acetate sheets are described. No special equipment is required.

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Some time ago it was necessary for the author to prepare on very short notice several lantern slides. Having no experience in this field and no special equipment the following method was tried. The material to be shown was typed on thin sheets (cut to the lantern slide size) of clear cellophane and mounted between two lantern-slide glasses. The success of this emergency method was so satisfactory that it was thought worth following a little farther. In the several articles on the preparation of lantern slides, (*1*) to (*9*), found in the literature there appears no method so easy and simple as this one.

It was found that for tables, and such data as could be typed, the most satisfactory results were obtained if, when the typing was done, a carbon paper was so placed behind the cellophane that a double impression was obtained, one on the front side from the typewriter ribbon and a second on the back from the reversed carbon paper. A typewriter which has "pica" type is more suitable for this purpose than one with larger type as it allows much more material to be placed on the slide and at the same time is large enough to be read easily when projected in the ordinary way, even from the back of a very large room. If sheets of cellophane about five-one-thousandths of an inch thick are used, the sheets are stiff enough to be much easier to handle than the thinner sheets and yet are thin enough to be used in the typewriter satisfactorily.

These prepared sheets are then permanently mounted between two glass slide-covers in the regular way or between two pieces of cellophane of the same dimensions (*i. e.*, $3\frac{1}{4} \times 4$ inches and $\frac{1}{32}$ of an inch thick). Another method is to hinge two glass or cellophane pieces (of the above dimensions) together, along the bottom, with a piece of tape and then leave the typed sheet in this holder only while using in the lantern.* Only two such holders are necessary and by this means the weight of, and the space occupied by, a large number of slides is greatly reduced. Care must be taken, however, not to smear the carbon typing on the back of the slide; this may be prevented by covering the back with another thin sheet and gluing the corners together.

Material such as curves, figures of apparatus, etc., which cannot be typed may be drawn on these sheets with India ink. For these slides the trouble of mounting may be avoided by drawing on thicker sheets ($\frac{1}{32}$ to $\frac{1}{16}$ of an inch thick) and using these, just as they are, for slides.**

* I am indebted to Dr. George Glockler for this idea.

** This method was tried at the suggestion of Dr. G. B. Heisig.

Black India ink shows up best on the screen but other colors work well enough to allow one to use several colors on the same slide to distinguish between different curves or different parts of the apparatus shown.

The latter type of slide is especially suited for the case where a slide is to be used only temporarily, as, for example, for a seminar talk or a single lecture. The figures may often be traced directly onto the slide and the material presented more accurately and easily than if the drawing is transferred by eye from the text to the blackboard. No great time or expense is involved in the making and when one is through using the slide the ink may be washed off and another slide made with the same piece of cellophane.

There is no danger of the cellophane being ignited in the ordinary projection lantern. However, if, for some particular lantern, such danger exists one may use the so-called non-inflammable cellulose acetate sheets.*

These slides do not give as good a projection as the best of the slides made in the regular manner but do give very satisfactory results, and from some points of view are to be preferred to the regularly made slides.

* Sheets of cellophane and cellulose acetate of various thickness can be obtained in many large cities at department stores or stores handling engineers' and architects' supplies, or direct from the manufacturers.

Cellophane may be obtained from: The du Pont Cellophane Company, Buffalo, N. Y.

Cellulose acetate (trade name, "Plastacelle") may be purchased from du Pont Viscoloid Company, Arlington, N. J.

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The present century is one in which the mantle of power is passing to the chemical industries. In all branches of production mechanical processes give way to chemical. —IGNACE MOSCICKI, *President of Poland*

A NEW TYPE OF CHEMISTRY

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Forsaking the regular high-school type of chemistry course, this course, after briefly taking up sufficient fundamentals of chemistry, such as equation-writing and atomic theory, starts in with a consideration of the chemistry of food, clothing, shelter, health, and, finally, the chemistry involved in the common labor-saving devices such as the automobile, radio, and motion picture.

This course emphasizes all of the minimum essentials of high-school chemistry as outlined by the Committee on Chemical Education of the American Chemical Society, but emphasizes the practical rather than the theoretical applications of chemistry.

By comparison of the experimental class with a similar class taught by usual procedure, practically no difference in accomplishment is shown when tested by the Iowa Chemistry Training Test. Such a course has tremendous possibilities. It should be especially valuable for the student who does not intend to pursue chemistry beyond high school.

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In a recent address before the teachers of Denver, Dr. Watson of Columbia University made the following statement: "We are attempting to teach a youth living in an 'aeroplane age' by methods in vogue at the time of the oxcart." This statement is only too true in regard to the usual presentation of high-school chemistry.

The greater proportion of high-school chemistry texts today are simply college books revised and simplified for high-school use. College chemistry is more or less a cataloging and arranging of elements, their compounds, properties, and uses, with the smallest emphasis being placed on the adaptation to modern life. Mathematics and laws which mean little or nothing to a boy or girl of fifteen or sixteen years of age are stressed heavily. While such a type of chemistry does make for certain types of mental training, the general result is to cause a hatred for the subject and a dislike which exists throughout life.

For the past five years I have been more and more impressed with the idea that high-school chemistry, if intended for the great majority of students today, must be modernized and brought up to date. With this idea in mind, I started, in September, 1930, a course in chemistry designed to make a greater appeal to the high-school student of today—a course of study which would arouse his interest and lead to a greater desire for chemical knowledge.

In starting this course of chemistry a sufficient foundation in atomic theory and formula and equation writing was given to enable chemical changes to be explained. Following that, a study of the chemistry of foods as being close to a student's heart was taken up, continuing with a study of clothing, shelter, health, and finally the chemistry involved in modern appliances

which are found in every home. The approach, therefore, is from the standpoint of use, working from that to the theoretical side. In this way many facts and laws considered by those in some branches of chemistry to be indispensable to a thorough knowledge, are omitted, while practical problems involving applications which can be carried directly into the home are stressed. In some ways the course approaches Dr. Sampey's course in "Pandemic Chemistry," and a suggested course in which experimentation is being done by the North Central Association. In discussing this course with high-school instructors in various parts of the country, I have found that all profess a decided interest along this line. The chief disadvantage lies in the fact that college entrance examinations still dictate and restrict the type of chemistry which high schools must teach; and until those in charge of secondary education can break away from the college requirements, little progress can be made.

While this course of chemistry uses an entirely different approach to the subject, all topics for a standard minimum high-school course in chemistry as proposed by the Committee of Chemical Education of the American Chemical Society, and published in the JOURNAL OF CHEMICAL EDUCATION [**4**, 640–56 (May, 1927)], are covered, the approach only being different. For example, the experimental class in studying foods found that ammonia was used in the production of ice. On their return to the laboratory the question was raised, "What is ammonia?" at which time they performed the usual experiment on ammonia and discussed through reference reading and text work the various processes for the manufacture of ammonia. A comparison of the minimum essentials with the course of study shows that all experiments indicated by the committee as essential were covered. The experimental class performed during the year a total of sixty-one experiments embracing all of the usual experiments together with many reports on topics given by motion picture, field trips, and lectures. While the course is on the face decidedly different, still no important essential has been omitted.

In conducting this experimental class, an ordinary section in chemistry, commencing in September and finishing in June, was taken as a basis.

On giving the standard Otis SA Higher Examination-C test, the following scores were made:

Median—110
Upper Quartile—121
Lower Quartile—106

which indicates that the group was composed of students of normal high-school intelligence, with very few in the lower scales. The course of study was followed as closely as possible, using the Denver adopted text (*1*) and the laboratory manual to accompany that text. This was supplemented by

reference material and library reading according to the references as indicated in the course of study. Because of the nature of the course, no textbook would exactly fit. If a textbook and a laboratory manual could be written for just such a course in chemistry, the results obtained would be far greater.

At the completion of the course as indicated in the accompanying outline, the Iowa Chemistry Training Test-A was given to the entire section. This same test was also given to a class which completed the usual chemistry in February, and likewise to one which had finished a year before. The accompanying table gives the results of the test as given to thirty-one students in the experimental section and twenty-nine students in a mid-year class.

	Experimental Class		*Regular Class*		*Normal*	*June Class*
	CT 1A Iowa	Otis SA IQ	CT 1A Iowa	Otis SA IQ	CT 1A	CT 1A
No. in class	31	33	29	10	..	161
Median	65	110	70	110	68	81
Upper quartile	78	121	90	121	94	100
Lower quartile	52	106	62	104	44	62
High score	121	126	151	123	..	143
Low score	28	86	17	93	..	12

The above data indicate that the probable error of difference of the median, 3.19, is not significant. By use of the formula, $\frac{D}{P\ E\ diff.\ medn.}$, the probable error becomes 1.567, which means that while there is some difference between the median of the experimental class and the median of the regular class, such a difference might be due entirely to chance. The P E diff. medn. was determined by use of the formula:

$$P\ E\ diff.\ medn. = \sqrt{P\ E^2_{medn.1} + P\ E^2_{medn.2}}$$

The above formula was obtained from Garrett, "Statistics of Education," page 126. It is to be especially noted that the two sections compared were in no way picked groups, but were simply sections assigned by the office in the regular manner.

The results indicate some rather striking features. First: The Iowa test was devised for the testing of students who had been taught by the regular methods, therefore, one would expect a rather marked difference in the median due to the content of the course. Yet only three points difference are noted between the median and the normal. Second: The lower quartile is eight points higher than the normal, indicating, possibly, that the slow or weak student of the section received more chemistry in proportion than did the weak student taught by the ordinary method. Third: The Iowa test is divided into four sections, of which the last section is entirely based on problems and gas laws. Inasmuch as the gas

laws have been omitted entirely and the problem solving was presented at the start of the course, as indicated by the outline, with no further attention being paid to it, one would naturally expect a section to do poor work in that line. The test seems to indicate that result, as the average score on the final question was twelve out of a possible forty-eight points. This part of the test forms the lowest part of the scores as made by members of the class.

In comparing the experimental class with the regular class which finished in February, in regard to intelligence as measured by the Iowa Essay Test, the median, upper quartile, and lower quartile are all three about the same, indicating that the classes rank very much alike mentally. As only ten of the classes that finished in September could be tested for IQ, possibly this is not a fair comparison. It is my feeling that the regular section is superior mentally because, out of twenty-nine people seven are members of the National Honor Society, while only one of the experimental section rates sufficiently high to be classified as eligible for the National Honor Society.

The chief difficulties in handling such a course are:

1. Reference material for large classes in most schools would not be available.

2. The use of field trips and motion pictures amplifying the course is not always possible.

3. The measurement of results in definite terms is somewhat difficult and tests devised to measure results of ordinarily taught classes do not exactly fit in this case.

4. Textbooks written for the usual type of chemistry do not readily lend themselves to use by such an experimental class.

The advantages of the course are:

1. A course of this type makes use of interest gained from actual observation rather than that derived from textbooks.

2. The deadly repetition which always follows high-school chemistry in college will be avoided, because material presented in college chemistry will have an entirely different aspect. The student will not recognize the college chemistry as being the same as that which he formerly had in high school.

3. For the student who never goes to college sufficient background will be given to enable him to understand all common chemical reactions and appreciate the tremendous rôle chemistry plays in every-day life.

This course is in no way offered as a completely worked-out syllabus. While embracing all essential points included in the minimum high-school course in chemistry, the emphasis upon practical use is increased, and the mere accumulating of chemical facts for future use is not stressed. The course is simply a foundation upon which further experimentation will be

conducted in the hope that eventually a satisfactory course suitable for high-school students may be devised.

Chemistry Outline

CLASS WORK	EXPERIMENTS
I. Introduction	
A. Alchemy and history of chemistry Ref. (*1*), pp. 1–6 (*2*), Chap. 1 (*3*), Chap. 1 (*11*), Chap. 1 (*15*), any chapter according to date	Manipulations of glass
B. Elements Ref. (*1*), pp. 22–34 (*6*), Chap. 7 (*11*), Chap. 2, 3, 4 (*15*), Chap. 8 (*19*), Chap. 2, 3, 4, 5, 7	
C. Matter and energy Ref. (*1*), Chap. 2 (*11*), Chap. 1 (*18*), Chap. 14	Lab. app. and meas. Bunsen burner
D. Atoms and molecules, chemical and physical change Ref. (*1*), pp. 105–107, 128, 16 (*11*), Chap. 3 (*15*), Chap. 9 (*18*), Chap. 1, 3, 4 (*19*), Chap. 2 Formulas	Properties Physical and chemical properties Properties of metals
E. Electrons and theory Ref. (*1*), pp. 121–136 (*4*), Chap. 7 (*15*), Chap. 14 (*18*), Chap. 8	
F. Metals Ref. (*3*), Chap. 11, 13 (*11*), Chap. 4 and 17 1. Properties Ref. (*1*) Chap. 3, 14 2. Rusting, example: chemical change 3. Metals and alloys: alkali metals Ref. (*19*), Chap. 33	Metals
G. Oxygen 1. Preparation Ref. (*1*), Chap. 4 (*11*), Chap. 5 2. Properties Ref. (*15*), Chap. 4	Oxygen Liquid oxygen Oxides and oxidation Dust explosions

CLASS WORK	EXPERIMENTS
3. Uses	
4. Oxides	
Ref. (*1*), Chap. 6	
(*11*), Chap. 5	
5. Combustion and catalysis	
Ref. (*3*), Chap. 1	
(*19*), Chap. 3, 20	
H. Important compounds	Acids
Ref. (*3*), Chap. 11	Sulfuric acid
1. Acids defined	Sulfur
Ref. (*11*), Chap. 9	Nitric acid
Common acids, properties, and formulas	
HNO_3, HCl, H_2CO_3, H_2S (Use Index)	
2. Bases defined	Bases
Ref. (*1*), Chap. 12	
Common bases, properties, and formulas	
NaOH, NH_4OH, $Ca(OH)_2$	
3. Salts derived from combination of acid and base	Hydrochloric Film on salt
a. Naming of compounds	Hydrolysis
Ref. (*19*), Chap. 2	
I. Equations	Equations
Ref. (*1*), pp. 68–71	
1. Balancing	
Ref. (*1*), Chap. 13, 14	
a. Valence	
2. Simple problems involving weight change	
Ref. (*1*), Chap. 24	
(*19*), Chap. 11	
J. Water	Water
Ref. (*21*), Chap. 7	Solutions
1. Solutions	
Ref. (*1*), Chap. 7, pp. 73–82	
Types	
2. Analysis and synthesis	
3. Composition, decomposition, sterilization	
Ref. (*16*), pp. 13, 35, 52	
K. Hydrogen	Hydrogen
Ref. (*1*), Chap. 9	
(*3*), Chap. 9	
(*7*), pp. 176–183	
(*11*), Chap. 7	
(*19*), Chap. 5, 20	
1. Preparation	
Ref. (*15*), Chap. 5	

CLASS WORK	EXPERIMENTS
2. Properties Ref. (*15*), Chap. 5	
3. Uses Ref. (*15*), Chap. 5	
4. Hydrogenation Ref. (*2*), Chap. 11	
II. The relation of chemistry to food Ref. (*21*), Chap. 13	United States Food and Drug lab. trip
Because food is uppermost in the thoughts of most high-school students, because of its necessity in maintaining life, and because the student should understand something of the materials necessary for maintaining life, he should have at least an elementary knowledge of important foods.	
A. Carbon cycle Ref. (*1*), p. 178 (*4*), Chap. 15, pp. 177–93 (*5*), entire book (*11*), Chap. 12 (*20*), pp. 70–75	
1. Carbon dioxide	Carbon dioxide
a. Photo-synthesis	Film on fertilizers
B. Important constituents of foods Ref. (*1*), Chap. 48 (*20*), pp. 72–5 (*22*), Chap. 13	
1. Carbohydrates	
a. Sugars	Sugars
Ref. (*1*), Chap. 45	Starch
(*1*), pp. 541–5	Hydrolysis of sugar and starch
(*2*), Chap. 9	
(*20*), pp. 4, 55, 64, 145	Flour mill trip
b. Cellulose	Sugar factory trip
Ref. (*2*), Chap. 7–10 (*22*), Chap. 13	
(1) Flour	
(2) Starch Ref. (*9*), Chap. 24	
2. Proteins	Proteins
Ref. (*1*), Chap. 44	Analysis of baking powder
(*11*), Chap. 24	
(*20*), pp. 3, 201, 219	Sodium bicarbonate
a. Packing industry	Flame tests
Ref. (*3*), Chap. 14	Packing-house trip
(1) Meats	
(2) Fish	
3. Fats Ref. (*1*), pp. 545–8	

CLASS WORK	EXPERIMENTS
(*2*), Chap. 11 (*22*), Chap. 20	
a. Oleomargarine	
b. Beef fat	
4. Minerals Ref. (*1*), pp. 539–41	
5. Water Use as a food. Why?	
C. Vitamins Ref. (*1*), pp. 551–3 (*5*), pp. 183–5, 255–82 (*14*), pp. 112–44	
1. Cod-liver oil	
2. Butter	Trip to Morey and Windsor plants
3. Flavors Ref. (*2*), Chap. 5 (*3*), Chap. 16	Babcock milk test
D. Food preservation Ref. (*20*), pp. 137, 152–5, 149	
1. Preservatives	
a. Canning	
b. Drying	
2. Refrigeration Ref. (*3*), Chap. 14 (*4*), Chap. 19	Colorado ice plant Ammonia
a. Ice manufacture Carbon dioxide Ammonia	
E. How to select foods Ref. (*1*), pp. 591–2 (*2*), Chap. 3 (*3*), Chap. 8	
III. The relation of chemistry to clothing	
Every person today should appreciate the rôle of the chemist in the production and furnishing of the fabrics which clothe the world. The new types of materials, rapid increase of beautiful shades, and the possibilities of their use are essential, especially to the future home-makers of our country.	
A. Cotton Ref. (*1*), Chap. 49 (*2*), Chap. 6 (*3*), Chap. 5, 21 (*11*), Chap. 26 (*21*), Chap. 19 (*22*), Chap. 8	Textiles
1. Growing	

CLASS WORK	EXPERIMENTS
2. Use of chemicals in combating the boll weevil	
3. By-products	
4. Hydrogenation of oils (See hydrogen, uses)	
5. Manufacture of explosives, lacquer, and paints Ref. (*1*), Chap. 47	
6. Other uses of cotton Ref. (*2*), Chap. 2	
B. Silk Ref. (*1*), pp. 565–6 (*21*), Chap. 19 (*22*), pp. 115–121, Chap. 8	
C. Rayon Ref. (*1*), pp. 561–4 (*3*), Chap. 21 (*4*), Chap. 7, 1 p. (*21*), Chap. 19 (*22*), Chap. 8	Film on rayon silk Textiles
1. Produced from cotton or wood Ref. (*22*), p. 118	
2. Production in different countries	
D. Wool Ref. (*1*), p. 565 (*21*), Chap. 19 (*22*), Chap. 8	
1. Spinning	
2. Artificial wood	
E. Leather tanning Ref. (*3*), Chap. 12 (*21*), Chap. 20	
F. Furs	
G. Rubber Ref. (*2*), Chap. 8 (*3*), Chap. 20 (*11*), Chap. 20, 22 (*21*), Chap. 20	Gates Rubber Co. trip
1. Artificial	
2. Natural	
H. Paper Ref. (*3*), Chap. 15 (*21*), Chap. 19	
IV. The relation of chemistry to shelter The modern home and office of today give a wonderful field for the study and appreciation of chemistry everywhere. The application and keeping the home in the best condition should be understood by all.	

CLASS WORK	EXPERIMENTS
A. Building materials	Calcium, barium, strontium
1. Bricks	Film on terra cotta
Ref. (*1*), Chap. 39	Film on cement
(*11*), Chap. 17–19	Film on bakelite
2. Cement	Film on optical glass
Ref. (*1*), pp. 434–7	
(*4*), Chap. 15	
3. Synthetic materials	
Ref. (*7*), Chap. 11	
4. Tar roofing	
5. Glass	
Ref. (*1*), pp. 429, 432	
(*7*), Chap. 5	
(*21*), Chap. 21	
B. Paints	Silicates, paints, lacquers
Ref. (*1*), Chap. 47	Film on turpentine
(*4*), Chap. 14	
(*21*), Chap. 18	
1. Oil paints	
Ref. (*1*), pp. 373–374	
2. Lacquers	
3. Coal-tar colors	
Ref. (*2*), Chap. 4	
C. Light and heat	
1. Electricity	
2. Gas and oil	
D. Sanitation in the home	Soap making
1. Soap	Soap testing
Ref. (*1*), Chap. 46	
(*4*), Chap. 21	
(*21*), Chap. 18	
V. The relation of chemistry to health	
The increase in the efficiency of life today is due largely to the chemist in producing better sanitary conditions, the control of disease, and the development of new types of synthetic drugs for the use of physicians and surgeons. For a student to do his best he must have every faculty at work all the time. Chemistry has an important place, therefore, in keeping a person in good health.	Lecture on health
A. Water	Analysis of water
Ref. (*21*), Chap. 7	Trip to City Water Works
1. Soft water	Chlorine
2. Hard water	Study of halogens
3. Purification	
Ref. (*1*), Chap. 31	
(*14*), Chap. 7, pp. 323–39	
(*22*), Chap. 5	

CLASS WORK	EXPERIMENTS
(*22*), Chap. 6	
a. Filtration	
b. Use of chlorine	
c. Testing of water	
4. Mineral water	
a. Carbonated water	
Ref. (*1*), p. 183	
B. Sanitation	
1. Removal of sewage	
Ref. (*14*), Chap. 7, pp. 358–73	
(*22*), Chap. 7	
2. Garbage removal	
3. Prevention of epidemics	
C. Air	
Ref. (*22*), Chap. 1	
1. Necessity for pure air	
Ref. (*14*), Chap. 3	
2. Humidity	
3. Local conditions affecting the health of a community	
4. Purification of air by plant life	
Ref. (*1*), pp. 177–8	
D. Serums	Louis Pasteur pamphlet
1. Vaccines	
Ref. (*11*), Chap. 25	
(*14*), Chap. 9, pp. 559–77	
a. Building of immunity in the body	
2. Value to the countries	
E. Drugs	Comparison of halogens
1. Effect of drugs on the body	Iodoform
Ref. (*14*), Chap. 8	Esters
2. Important drugs	
a. Magnesium sulfate	
b. Calomel	
c. Iodine	
Ref. (*14*), Chap. 6, pp. 272–296	
d. Bromides	
F. Glands	
1. Internal secretion	
Ref. (*7*), pp. 269–78	
2. Thyroid, etc.	
Ref. (*14*), Chap. 6	
G. Pain-alleviating materials	
Ref. (*14*), Chap. 8, pp. 445–523	
1. Cocaine	
2. Morphine	

CLASS WORK	EXPERIMENTS
3. Chloroform	
4. Ether	
5. Novocaine	
H. Alcohols	Film on ethyl alcohol
Ref. (*1*), pp. 501–5	
1. Effect on the body	
2. Methyl	
3. Ethyl	
4. Fusel oils	
VI. The relation of chemistry to amusements	
The proper use of leisure time is accepted as one of the cardinal principles of education. The rôle of the chemist in furnishing the relief from monotony and the development of true pleasure is vital.	
A. Automobile	
1. Iron and steel manufacture	
Ref. (*1*), Chap. 36	Film on carborundum
(*3*), Chap. 1	
(*7*), Chap. 10	Film on steel
(*11*), Chap. 18	
2. Alloy steels	
Ref. (*7*), Chap. 10	
3. Alloys	
Ref. (*1*), Chap. 37	
4. Rubber	
Ref. (*1*), pp. 498–9	
(*7*), Chap. 8	
5. Artificial leather	
Ref. (*1*), pp. 534–7	
6. Gasoline and oils	Film on lub. oil
Ref. (*1*), Chap. 43	Trip to oil refinery
(*4*), Chap. 12	
(*11*), Chap. 22	Oil distillation
B. Aeroplane	
Ref. (*1*), Chap. 37	
(*4*), Chap. 2	
1. Light alloys	
2. Cellulose lacquers	Film on nitrocellulose
Ref. (*1*), pp. 534–7	
(*7*), p. 442	
C. Motion pictures	Colorado General Hospital
Ref. (*1*), Chap. 33	
1. Celluloid	Film on trip to filmland
2. Effect of light on silver	
3. Talking pictures	
4. Color pictures	
5. X-rays	

CLASS WORK	EXPERIMENTS
D. Radio	
Ref. (*4*), Chap. 16	
1. Materials made by the chemist	
2. Television	
E. Musical instruments	
1. Phonograph	
VII. Methods of the chemist	Speed of reactions Amphoteric elements
A brief study of chemical analysis with the simple reactions of the metals, methods of testing, working of equations, should be a part of any person's knowledge of chemistry. This would be obtained by a brief study of the six groups of qualitative analysis and the tests for simple acids.	

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THE NEW-TYPE (OBJECTIVE) EXAMINATIONS IN HIGH-SCHOOL CHEMISTRY*

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Educational research has contributed technics for building and standardizing tests. These results have been used to a certain extent in developing objective tests in chemistry. Tests must be measured by acceptable criteria, representative of which are: validity, reliability, objectivity, ease of administration, ease of interpretation, mechanical merit, etc.

Progress in construction and use of objective tests in chemistry has been relatively slow. Many teachers still use the more subjective devices for measuring results of teaching rather than the better objective methods. This is due to ultra-conservatism; lack of appreciation of the value of objective measures; and a feeling of complacency that because the teacher is a scientist, his work must be scientifically right. Knowledge of chemistry does not make a good chemical engineer, nor does a knowledge of chemistry necessarily make a good chemistry teacher.

. . . . . .

The history of the development of educational measuring devices, both the intelligence tests and the achievement tests, makes an interesting chapter in the story of educational advancement. It is a story of experimentation and careful study of results, and as is true in any scientific project, many of the results have been discarded. But out of this long program of study and experimentation there have been culled results which seem to reward the workers for the time and effort expended. These results consist of: (1) the intelligence tests through the use of which it is possible to calibrate the student groups according to ability; (2) the standardized achievement subject tests, useful in comparing the achievement of a given group or groups with the achievement of a much larger group on which standards or norms have been established; (3) the unstandardized objective tests, for measuring the progress of the teacher's own group on a basis of particular subject matter; (4) certain technics for the building and standardizing of new and better measuring instruments of subject matter, and methods of administration. This paper is limited to a discussion of the unstandardized classroom achievement tests, but an attempt will be made to include both the standardized tests and the new type of objective examination.

Kinds of Examinations

In general the examinations or tests may be grouped under several headings: the traditional examination, the standardized test, and the unstandardized objective examination. It is not necessary to discuss the

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traditional type examinations since they are so well known to all teachers. A brief definition may serve to clarify certain differences which exist between the standardized tests and the newer achievement tests.

A. *Standardized Tests:* These tests have been in use for a long period of time—approximately twenty-five years. They are objective-type examinations, in the administration of which such factors as time, type of response, etc., are controlled. They also provide norms or standards by which the accomplishment or achievement of an individual may be compared with the performance of a large number of other students tested under the same or similar conditions.

B. *Objective Tests:* In part this name is a misnomer and might be interpreted to mean that the other tests did not aim at objectivity. The new-type test is essentially the same as the standardized test excepting that it does not have the background furnished by the results of experimental study and standardization. And while it implies a flexibility to meet local conditions of curriculum, it is limited in its value as a measuring device by not having the advantages of comparison with norms.

A study of the literature dealing with tests and measurements makes one conscious of the great variety of terms used to define and describe the products of the test builders. Quoting from Ruch (*1*), "The type of examination with which this book deals principally is variously termed 'informal,' 'new type,' 'unstandardized,' 'short answer,' and 'objective.' None of these names is particularly fortunate since each emphasizes but a single one of several important attributes of such examinations." It would seem then that these new examinations are so inclusive that to do them justice it will be necessary to either coin a new name, or describe them more fully by using several adjectives.

Function or Use of Objective Tests

The uses which may be made of test results have increased rapidly as the tests have been refined to achieve greater validity. In addition to the use of test scores for passing or failing students, the results are serving the teacher, the supervisor, and the administrator in many ways that the results of the traditional examinations could never do. Some of the uses which may be made of the test results by the teacher of chemistry, the supervisor of science, and the administrator are briefly outlined as follows:

A. Supervision of instruction
   1. Rating of teachers
   2. Determination of quality of instruction
   3. Testing of methods of instruction

B. Sectioning, grading, and promoting pupils
   1. Informing pupils of their progress
   2. Furnishing an incentive to study
   3. Prediction of success
   4. Determination of credits
   5. Distribution of pupils for promotion

C. Diagnosis of difficulties
   1. Discovering weaknesses of pupils
   2. Discovering the difficulty of subject matter
   3. Discovering weak spots in instruction
   4. Discovering weaknesses of teacher

D. Research

While the uses just mentioned are important it must not be assumed that the use of objective tests, either standardized or unstandardized, will solve all educational problems. The extent to which an objective chemistry test will serve in the educational program depends upon the validity of the test and upon the ability of the teacher to use the results as a tool in the further teaching of his class. The results of batteries of tests in any subject are superior to teacher marks, although they require more time than a single test and the cost is greater.

Types of Objective Tests

A study of various new-type examinations reveals some extremely interesting methods of construction. Conneau (*2*) in analyzing 375 objective examinations submitted in a contest found that there were seventeen different types represented. In these tests more than ninety per cent of the test items consisted of the following types: completion, true-false, multiple-response, matching, identification. The type of form used in the construction of a test will be determined by the objective to be attained in the examination. An outline of the several types of tests in common use is included and represents an adaptation of the findings of Conneau.

I Recall Types
   1. Simple recall
   2. Completion
   3. Short-answer

II True-False Types
   1. Yes—No
   2. +, −, 0
   3. Right—Wrong
   4. True—False, doesn't say, etc.

5. Converse statements (mathematics)
6. Diagrams (right and wrong)
7. Synonym

III Multiple Choice Types
1. One—two—three—four type
2. Best answer

IV Matching Types
1. Perfect
2. Imperfect
3. Multiple answers

V Analogies

VI Regrouping Types
1. Chronological
2. Order of operation
3. Mixed sentences
4. Cut-up pictures, maps, etc.

VII Computations
1. Examples
2. Problems

VIII Construction
1. Mathematical figures
2. Diagrams (science)
   (*a*) Construction
   (*b*) Completion
   (*c*) What is wrong?

IX Identifications
1. With drawings
2. Without drawings

X Reproductions from memory (poems, axioms, laws, formulas, symbols, equations, etc.)

XI Correction of errors (in grammar, punctuation, capitalization, spelling, etc.)

XII Redundancies or cross-outs

XIII Map location

XIV Deduction of conclusions from premises

XV Translations

XVI Miscellaneous and mixed types

The young teacher who is eager to do an efficient type of teaching may be alarmed by the great number of types of test from which a selection may be made, either in constructing an objective test or in selecting a published one. And it should be particularly emphasized that while each of the different types may have some peculiar merit, selection of the type or types used will have to be made on the basis of adaptability to the particular work. It is probably true that in science as in most high-school subjects several types of tests will afford variety and make the work more interesting.

Criteria for Judging a Test

The teacher, supervisor, and administrator planning a testing program will need to study the problem of test selection carefully in order that the test selected for use may serve in accomplishing the desired results. Judging the value of a test may be accomplished most easily and satisfactorily by using certain criteria. These criteria in general are the same for both the user of the test and the builder of the test. The following outline suggests some of the principal criteria of a good test or examination.

1. Is the test valid? It must measure that which it is desirable to measure, including all the essentials and excluding non-essentials. The content of courses of study, texts, and researches must be recognized. The test must also be valid from the statistical standpoint.
2. Is the test reliable? To be reliable the test must have been administered to a large number of students of the given grade, selected from representative schools.
3. Is the test objective? The test may be scored by means of a key with the same accuracy by any number of persons. Personal opinion is not required in interpreting answers.
4. Is the test easily administered? The test must be so prepared that directions for administration, scoring, and interpretation of results may be easily understood. Student directions must be clearly, simply, and accurately stated.
5. Are results easily interpreted? A test to be useful must yield results which are usable for grading, promoting, and diagnosing difficulties.
6. Are there duplicate forms? The test must be prepared in duplicate forms which are practically equivalent.
7. Is the test mechanically good? From the mechanical point the test must be attractive, set in type easily read, and contain good pictures and diagrams. The items must be arranged for convenient scoring.
8. Does the test provide for diagnostic use? The test should provide norms and other data which will permit of the results being used for diagnostic purposes.

9. What is the time requirement for administration of the test? The time required for administration of the test is an important factor. It should be of such length as to make possible its use within the conventional class period.

Objective Tests in Chemistry

A catalog of the published standardized chemistry tests shows that there are at present only seven, with one or two other projects under way. These tests, for convenience of discussion, will be classified in four groups, as follows:

I. General Achievement Tests

1. Powers General Chemistry Test, Forms A and B. Published by World Book Company, Yonkers, New York. A test of accomplishment of students in chemistry in two parts: Part I, a test of range of chemical information (30 questions), and Part II, a test of ability to do tasks in chemistry (37 problems). Time of administration is 45 minutes. The test is designed for high-school use. A manual of directions for administering, scoring, and interpreting results accompanies the test.
2. Rich Chemistry Test, Forms Gamma and Epsilon. Published by Public School Publishing Company, Bloomington, Ill. An achievement test in chemistry for high-school use. Each form consists of 254 response items, and requires about 25 minutes for administration. The tests are scored objectively, and attainment is measured in (1) ability to think; (2) information; (3) ability to solve numerical problems; and (4) habits and knowledge acquired from work in the laboratory. Teacher's manual is ordered separately.
3. Gerry's Test of High-School Chemistry, two forms. Published by Harvard University Press, Cambridge, Mass. The Gerry test is also an achievement test in high-school chemistry. It is similar to the other tests, consisting of about 25 items in each form. The basis of selection of the test items was an analysis of College Board questions, (1911 to 1920), checked against four textbooks. The reliability is low.

II Instructional Tests

This type of test consists of a series of tests based upon chapters of the text or upon units of work.

The Glenn-Welton Tests.

Published by World Book Company, Yonkers, N. Y. A series of tests based upon chapters or units of work. The tests include the true-false, multiple choice, fill-in, and problem-solving

types. Norms based upon extensive testing are provided. Teacher's key and manual are ordered separately. The tests offer the teacher a means of measuring the class at frequent intervals. One of the principal difficulties of using these tests is that they are not based on a course of study and, therefore, include items not always taught.

Lyon & Carnahan Chemistry Test. Published by Lyons & Carnahan, Chicago. Similar to Glenn-Welton but not as complete.

III. College Placement Tests

These tests may be used as final achievement tests in high-school chemistry, but find principal use in preliminary testing of college freshman.

Iowa Placement Examinations, CA-L and CT-I. The tests may be described briefly as follows: (1) Chemistry aptitude, CA-1 (2 forms) is written in four parts devoted to simple arithmetic of chemistry; paragraph content and relationship; chemistry reading comprehension; and interest in common chemical information. (2) Chemistry Training, CT-1 (2 forms) in four parts measures knowledge of chemical processes; valence, equations, and formulas; applications of chemistry in true-false questions; and chemical problems.

IV. Laboratory Tests

Persing Laboratory Chemistry Test, Forms A and B. Published by Public School Publishing Co., Bloomington, Ill. This test is an objective measurement of the achievement of pupils in laboratory technic in high-school chemistry. It includes multiple choice statements; completion type problems; completion of apparatus drawings; and checking incorrectly set-up apparatus. Each form consists of 69 items based upon analysis of conventional laboratory manuals and direction sheets. A teacher's manual and scoring key accompanies the test. The time required is about 40 minutes.

Obviously there must be some very definite reasons why so few tests have been prepared in this field of science, where one might expect to find leadership in constructing scientific measuring devices. It might be expected that science teachers would lead in discarding subjective measuring devices and in the refining of technics for building better objective tests, but the facts seem to indicate that instead of assuming a leadership in the work, they are scarcely keeping pace with work being done in other subjects, such as mathematics and English. The factors or causes which possibly contribute to this condition of retarded progress in the field of ob-

jective measurements, on the part of high-school chemistry teachers, are numerous and may not always be easily identified. For purposes of this discussion a few of the factors which seem to have contributed to this condition of inertia among high-school chemistry teachers will be summarized as follows:

1. Lack of organized course of study.
2. Desire to meet college entrance requirements through a modified content, taught by so-called new methods.
3. Objectives stated in terms of intangibles, such as abiding interests, appreciation, health, worthy use of leisure time, scientific attitudes, etc.
4. Slashing the course of study in an attempt to individualize the instruction.
5. Accepting the textbook as a course of study rather than as an aid in realizing the goal of a course of study.
6. Teeter-tottering between chemistry as a pure science and pandemic chemistry.
7. The chemistry teacher is frequently untrained in educational technics, the training in education consisting of a certain required number of semester hours, which may be history of education, methods, etc.

It is fair to assume that while other causes have exerted an influence tending to prevent a popularizing of achievement tests in chemistry, an outstanding factor has been the teacher. As indicated in one of the causes listed above, many teachers have had no training in the use or construction of educational measuring instruments. This will be especially true of the older teachers in the profession. On the other hand, the prospective teacher, or the younger teacher, has had training in educational methods, history of education, psychology, philosophy, and perhaps a course in measurement. But in almost all such courses the work deals with a review of published texts and tests. Tests are administered, scored, and treated statistically. This about covers the work in most courses of this kind. The real work of practice in the technic of building tests and diagnosing the results is left to others. Incidentally, it is possible that the publication of tests in any field keeps pace with the demand. The demand on the other hand is a by-product of a recognized need by the chemistry teacher and unless the teacher can use these devices intelligently in measuring both his own progress and the progress of his students, the tests become mere playthings. How to use the test results is a problem that puzzles many teachers.

Test Laboratory Technic

It has been requested that a little time be given to a résumé of the technic employed in constructing the Persing Laboratory Chemistry Test.

This work has been reported in an article appearing in the JOURNAL OF CHEMICAL EDUCATION, July-August, **1929,** pp. 1321–7.

The tests were planned and constructed in an attempt to measure more accurately the quality of laboratory skills developed. The difficulties of measuring laboratory technic and skill through the medium of written tests were considered and studied. And it was decided that the test should be set up in a form that would most nearly approach the actual laboratory situations. This was carried out through the medium of drawings representing apparatus to be completed; checking incorrectly assembled apparatus; selection of apparatus for the preparation of certain materials; and problems in which judgments must be made based upon certain properties of substances in relation to others.

The test may be discussed with the greatest economy of time by applying the criteria set up for judging the worth of a test. These are as follows:

1. Is the test valid?

The test has been constructed using representative problems and materials as shown by an analysis of available laboratory manuals, courses of study, and suggestions from teachers and supervisors. Many worthwhile items included in the initial tests were rejected later because they were not of common occurrence.

2. Is the test reliable?

The test is in two forms of equivalent value as shown by the administration of the test to more than 3000 students in representative high schools throughout the United States. The correlation value is 0.87 and, while based upon fewer than the cases cited above, further study shows these figures are reliable. The data show that the probable error of a score is about three points.

3. Is the test objective?

The test may be scored by one or more individuals without variation in score by means of the key supplied. Teacher interpretation of answers is not required to determine whether the answer is correct or incorrect.

4. Is the test easy to administer?

The instructions and directions are simple and easy to follow. Pupil directions are given in simple direct statements which are not difficult to understand.

5. Have norms been determined?

Medians and percentile norms have been prepared.

6. Are there duplicate forms?

The test is prepared in two forms, A and B, of approximately the same difficulty.

7. Is the test mechanically good?

The publishers have done an exceptionally fine piece of work in preparing

cuts and setting up the test. The arrangement is good and scoring may be done without difficulty.

8. The use of the results obtained by administering the Laboratory Chemistry Test will be determined largely by the individual teacher of chemistry. Some uses which may be made of the results are suggested in the following analysis:

(*a*) As an achievement test in laboratory technic. This is the main purpose of the test.

(*b*) May serve as a means of comparing various classes in the same building, or in comparing the scores of a group of students with the medians given on page 2.

(*c*) May serve diagnostic purposes.

(*d*) In connection with the diagnostic work, may serve in setting up remedial work in technic.

9. What is the time requirement for administration of the test?

The test may be given during a 40-minute period.

The extent to which the test covered the laboratory phase of the high-school course in chemistry may be estimated by considering the analysis of the test which follows. A summary of the facts included in the problems shows the following content:

1. Filtering: recognition of "filtrate" and "precipitate."
2. Flames: a study of flame structure (hottest part, oxidizing flame, reducing flame).
3. Apparatus:
   (*a*) Completion Type: problems involving the completion of apparatus used in the preparation of ammonia, sulfur dioxide, testing for carbon dioxide, etc.
   (*b*) Incorrectly Assembled Types: problems in checking types met with frequently and including unsealed thistle tubes, submerged delivery tubes, burners when not necessary.
4. Borax Beads:
   (*a*) Identification of beads containing typical salts.
   (*b*) Beads prepared in reducing flame instead of oxidizing flame.
5. Electromotive Series of Metals: problems of metallic displacement and the nature of the ions in the resulting solutions.
6. Distillation: study of the process and applications.
7. Conductivity: identification of electrolytes and the polarity of the electrodes.
8. Electrolysis: water, sodium chloride solution, and potassium chloride solution.
9. Principles of Gas Collection: problems involving density, solubility, and chemical activity with water.

10. Drying Gases: problems involving the use of several drying agents with various gases.
11. Reduction and Oxidation Reactions.
12. Classification of Apparatus: adaptability of certain types of apparatus for the preparation and collection of a given substance.

The test offers an approach to the objective measurement of laboratory technics. It is undoubtedly true that more refined tests will be prepared as the measurement of this phase of science work is given the consideration it deserves. There seems sufficient reason to challenge any rating scheme for laboratory work based solely on the correct or incorrect answers written by students on the laboratory sheet during the experiment. These results in a large measure constitute a set of facts but do not tell a single thing about the skill of the student, his technic, or his ability to study critically the merits of a set-up of apparatus.

The tests are too young to make any prediction as to their general acceptance or popularity among chemistry teachers. It must be remembered that the Laboratory Chemistry Tests represent a pioneer piece of work in testing in a field where the high-school chemistry teachers are still using subjective methods of evaluating the outcomes of laboratory work. In this connection mention must be made of the work done by Rakestraw, Webb, and Horton. Each of these men has made real contributions toward objective measuring of laboratory technic and achievement. And, as has been pointed out earlier in this paper, the use of scientific measuring devices, in chemistry (both classroom and laboratory) and other science subjects, depends upon certain curricular and supervisory adjustment. Furthermore, the science teacher must not hide behind his "science" as a protection against his unscientific methods in measuring his own work and the work of his students.

In conclusion it may be pointed out that in the field of science, especially chemistry, there is an unlimited opportunity to exploit the advantages of objective measuring, and the teachers of science should be leaders in construction and refinement of objective tests. This is true to a greater degree today than in the past because of the research contributions which have been made by the specialists.

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IS A HIGH-SCHOOL CHEMISTRY CLUB WORTH WHILE?

OTTO J. WALRATH, BLOOMFIELD HIGH SCHOOL, BLOOMFIELD, NEW JERSEY

Although much time and effort are required, a high-school chemistry club can be of great aid to the department by providing model plants and mineral collections, by raising money for moving picture machines, films, etc., and by supplying other equipment of lasting value. Some of the major projects carried out during the past few years by the Bloomfield High School Chemistry Club are described.

. . . . . .

Many chemistry teachers are skeptical concerning the value of a chemistry club. Occasionally I hear one say that he has tried it and felt that for the time and effort required, it was not worth while. That has not been

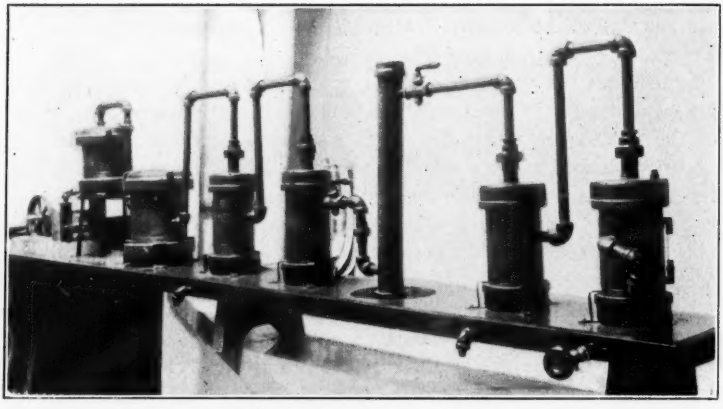

FIGURE 1.—MODEL SULFURIC ACID PLANT. IT WORKS

our experience. Although we admit that it requires much time and planning, we feel that our club has more than justified its existence.

The Bloomfield High School Chemistry Club was started shortly after the end of the World War. Incidentally, the first president was a young man who had fought with the Marines in France. Feeling that his education was not satisfactory, he returned to our school at the age of twenty-four and prepared for entrance to a technical college. At that time the club boasted of about twenty members. Today we have a hundred, the largest club in the school.

Our meetings are of the usual type. There are talks by men from various chemical plants, demonstrations by club members, moving pictures of chemical operations, etc.

Our activities are many. We make visits to industrial factories. The club furnishes a prize medal twice a year to the member of the graduating

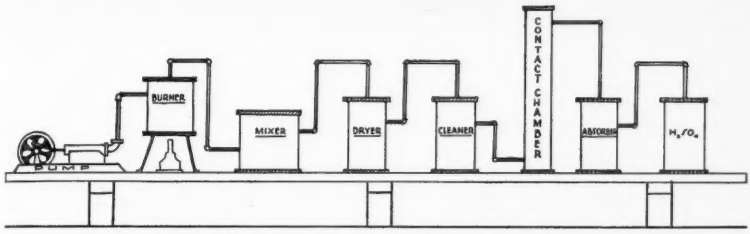

FIGURE 2.—DIAGRAM OF CONTACT-PROCESS PLANT

class who has made the highest average in chemistry. All of these things are excellent, but we feel that the projects carried out are the most valuable, and it is to these that we owe most of our success.

The first project of the club consisted in making frames for charts, pictures, chemical trees (coal tar, etc.) to be hung in the lecture hall. As time went on, we became more ambitious. We decided that we wanted Dr. Edwin Slosson from Washington to speak to the students, their parents, and friends. Dr. Slosson's visit was the topic of conversation for weeks. It gave us publicity and acted as a strong impetus. This lecture strained our financial resources to the limit, and we had to go slowly for a while.

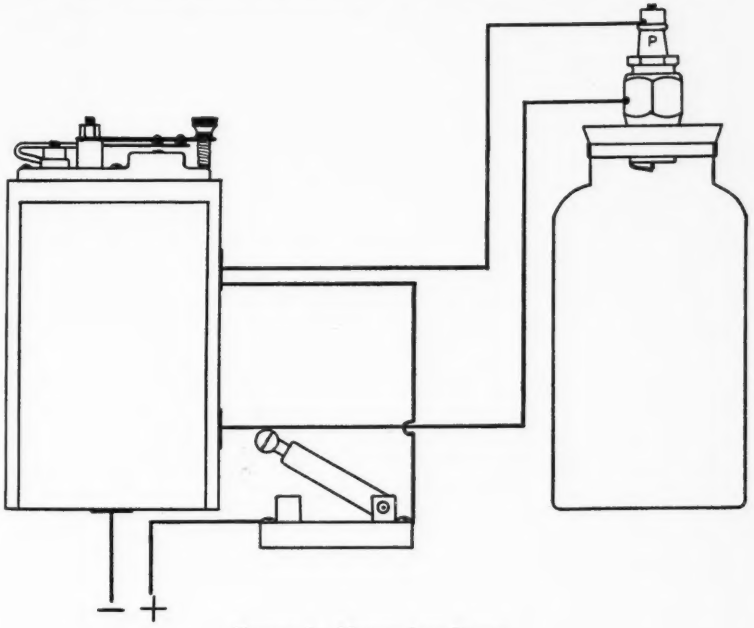

FIGURE 3.—NITRIC ACID PLANT

With the inauguration of the American Chemical Society Prize Essay contest, we realized that we should have a more extensive chemical library. Within two years we raised a hundred and fifty dollars, with which we bought books. Many of our students wrote essays, and we won three state prizes.

For those teachers whose Boards of Education will not furnish the money, or for those who can use model plants and other equipment for which they do not care to ask authorities, our other projects may be of interest.

Using Dr. Dennis' plans as given in the JOURNAL OF CHEMICAL EDUCATION in the October, 1929, issue (modified to some extent) a group of our boys built a model sulfuric acid plant, a picture of which is shown in Figure 1. The diagram, Figure 2, is drawn to scale. Except for one or two parts, it is made of cast-iron piping and fittings. In the contact chamber we used platinized asbestos. The total cost exclusive of the pump, which we already had, was sixty-five dollars. The good feature about the plant is that *it works*. To accompany this model plant, another group assembled a companion apparatus to prepare nitric acid synthetically, using a Model T Ford spark coil, a Ford spark plug, and a large glass bottle and stopper. This is shown in Figure 3.

Many of the boys and some of the girls are interested in the slide-rule. As the club furnished the money, an eight-foot demonstration rule is now permanent equipment in the lecture hall. At present a group is working on an apparatus to show the effect of ultra-violet rays on crystals. As zinc ores are especially sensitive to these rays, it will be of extra interest in this locality. Still another group is helping to get ores for a permanent layout of the various sources of the metals.

This year we have bought a modern moving-picture machine at a cost of over two hundred dollars. Moreover, we have selected one that can be converted at small cost for use with sound when needed. With the machine we purchased films on the subjects of steel and sulfur. As time goes on, we shall add more films which can be used to supplement the work in the classroom and laboratory.

As to the future, we are looking for new worlds to conquer. As the club is getting large, and as the members have so many diversified interests, we shall probably copy the arrangement of the American Chemical Society and have several sections according to special bents, such as photography, mineralogy, etching, etc.

Mr. Paul M. Mazur points out that "The world is now only at the threshold of industrial and commercial expansion. The possibilities of new markets and new industries become overwhelming if even the slightest increase is effected in the demands of all men and women." Such is the faith behind engineering research.—WILLIS R. WHITNEY

A DIFFERENT OPEN-HOUSE PROGRAM

DOROTHY ENGLE AND JEAN MCBRIEN, ALBION COLLEGE, ALBION, MICHIGAN

The authors present the scheme and the program of an open house in which ten different departments of the college participate.

. . . . . .

There is nothing new in the idea of "open house" in chemistry regardless of the name by which it may be called. But there are many modifications of this idea. In Albion College, a college of 800 students, we have carried out several open-house programs in alternate years, and we believe that the type we have had the last two times may be of interest to others, and for this reason we are submitting the following complete program.

1. Astronomy—Observatory

   Weather permitting, the observatory will be open for viewing the heavens through the telescope. (The sky was clear, and Jupiter in view, and people stood in line the whole evening to look through the telescope).

2. Physics—Physics Building

   1. Voucault pendulum
   2. Gyroscopic wheel
   3. X-ray machine
   4. Resonance—the principle of radio tuning
   5. Color photography
   6. Free fall apparatus
   7. Crookes and Geisler tubes
   8. Discharge through tubes containing various gases of the air
   9. Demonstrations in polarized light

3 Home Economics—North Hall

   Modes of Our Modern Maids
   Elementary and advanced clothing classes
   My Ideal Home
   Home architecture and interior decoration
   Daily Dietary for Moderately Active Man
   Dietetics classes
   Getting "Your Money's Worth"
   Marketing class
   Hints for the Home Nurse
   Home nursing class
   Table Laid for the Informal Dinner
   Food classes
   "Textile Fibers and How to Know Them"
   Textile class

4. Art—Art Building

   The art rooms will be open for observation of the art collections

5. Bible—Robinson Hall

   8:00 P.M. Stereopticon lecture, "Passion Play at Oberammergau." 20 minutes
   9:00 P.M. Stereopticon lecture, "Palestine." 20 minutes
   7:30–9:30 Exhibition of Costumes and Curiosities of Palestine

6. Biology—Robinson Hall

Room 130

- Apparatus and methods for making bacterial counts
- Bacterial counts of milk
- Fungi on food
- Exhibit of local fungi
- Reaction of flowers to aqua ammonia
- Insectivorous plants
- Plant parasites
- Inheritance of definite characters in humans

Room 213

- Exhibit of types of vertebrate brains
- Marine molluscs
- Life history of fresh water clam
- Common arachnids
- Chick embryos—stages
- Activities of protoplasm
- Animal parasites
- Osmometer

Room 216

- Desert plants
- Balanced aquarium
- Hand-made charts
- Responses of plants to stimuli

Room 205

- Technic of making slides
- Microscopic structure of various types of tissues
- Display of microscopes and accessories

Room 312

- Dissected cat
- Protozoan cultures
- Animals found on collecting trips—living specimens
- Fossils
- Plancton and apparatus for collecting

7. Psychology—Robinson Hall

The public may observe or participate in the following psychological phenomena at any time during the evening from 7:30 to 9:30

1. Light Intensity Discrimination
2. Mirror Drawing. Running the Maze
3. Sound. Optical Illusions
4. Retinal Induction and Color Blindness Detection
5. Localization of Touch Spots
6. Apperception and Reasoning Demonstrations

Any one wishing to do so may take any of the following tests at either 7:30 or 8:30

7. Tests for Memory of Names and Faces
8. Tests for Automobile Drivers
9. Introvert-Extrovert Tests

The following experiment will be given only once during the evening, namely at 8:30

10. Crime Detection

8. Library

The library will be open and there will be an exhibit of rare books and periodicals

9. Chemistry—Chemical Laboratory

Room 1

1. Explosive bubbles
2. Burning rings
3. Melting iron with cold water

Room 5

1. Preparation of picric acid
2. Making dyes
3. Steam distillation
4. Dyeing—vat dye (indigo)
5. Mordant dyes
6. Precipitation dye

Room 2

4. Carbon in steel
5. Heat units in gas
6. Carbon in automobile oil
7. Viscosity of automobile oil
8. Testing gasoline
9. Heat units in coal
10. Sulfur in coal
11. Alcohol test
12. Clinical tests
13. Acidity tests

Room 3

Colored flames and spectroscope

Room 4

Surveying instruments
Six foot slide-rule

7. Bleaching
8. Dyeing with foods
9. Oxalic acid
10. Making wintergreen
11. Breaking wintergreen into "parts"
12. Fountains
13. Saccharin—500 times as sweet as sugar
14. Qualitative tests—dime and penny
15. Testing for acidity of vinegar
16. Cleaning silverware
17. Fat in milk
18. Oleomargarine and butter: spoon test
19. Oleomargarine and butter: milk test
20. Smoke screens
21. Magnesium ribbon
22. Atom models
23. Size of molecules and atoms
24. Chemical composition of man
25. Mirrors
26. Preparation and properties of oxygen
27. Boiling points at various pressures
28. Softening of water
29. Explosives

Room 6

Combustion of organic compounds

Room 7

7:30 and 8:30 Moving Picture Show, "Story of Steel"

10. Susanna Wesley Hall, the women's dormitory, will be open to visitors and tea will be served in the art studio during the evening

The general public of the city was invited through posters and announcements in the newspapers. The students and faculties of eighteen nearby high schools were invited by letters and posters. The register showed that about 1000 persons attended. Punch was served in the Art Studio, where music was provided during the evening by a student orchestra.

The open house was undoubtedly a success. In chemistry, we feel that one of the chief values was in the interest created in the preparation of the experiments and in the stimulation of the study of chemistry it created. The students were urged to express their originality, suggestions and guidance being given when needed. Allowances were made for the time lost from the regular laboratory period preceding the program. The most interested students in the department were selected for performing or setting up the experiments. It was arranged that two or more students had charge of each exhibit, so that one could be on duty while the others had an opportunity to visit the exhibits of the other departments.

SOME REMARKS ON THE DETERMINATION OF FORMULAS

KENNETH D. DODDS, BELLEVUE HIGH SCHOOL, BELLEVUE, PENNSYLVANIA

The chemical reasons behind the rules for calculating formulas are obscure to many beginners principally because of the impression that the validity of such calculations is somehow dependent both upon the statement of the analytical data in terms of percentage composition, and upon the means by which the final numbers (when fractional) which represent the numbers of atoms of each element in the compound are reduced to whole numbers.

It is the purpose of these remarks to elucidate the chemical aspects of the arithmetical operations by which formulas are determined, and to show that they can be deduced without regard to percentage composition, and that there is a choice of ways for reducing fractional results to whole numbers of atoms.

. . . . . .

The first operation in calculating formulas, by present methods, requires the use of the percentage composition of the compound. This is the case both with the traditional method, in which the percentages of the constituent elements are divided by their atomic weights; and with Stone's excellent method (*1*), by which a provisional molecular weight is found as the quotient of the atomic weight of any element in the compound by its percentage.

In case the composition is not given in percentage, the textbooks state that the known data must be reduced to that basis before proceeding with the calculation. The beginner is usually unfamiliar with the reasons for expressing analytical results in terms of percentage, and therefore gets the impression that chemical formulas are linked in some obscure way with the purely arithmetical phases of percentage composition.

The unnecessary rigidness of the stipulation regarding percentage is indicated by two considerations: first, that the weights of the elements in a sample of a compound are proportional to their numbers and to their atomic weights; and second, that the expression of analytical data in terms of percentage cannot have any peculiar virtue, since elements are present in any weight of sample in relatively the same proportions as in one hundred units of weight. For these reasons it would seem that neither the weight of sample analyzed nor the system of weights employed have any indispensable bearing on the computation of formulas.

To transfer this discussion to a concrete problem, let us attempt to find the formula of a compound directly from the following analytical data:

Calcium	0.2581 gram
Carbon	0.1548 gram
Oxygen	0.4129 gram

Designating numbers of atoms by η,

$$\text{Weight Ca} \propto \eta\text{Ca} \times \text{atomic weight Ca.}$$

Hence

$$\eta Ca \propto \frac{0.2581}{40} \text{ or } 0.00645$$

$$\eta C \propto \frac{0.1548}{12} \text{ or } 0.0129$$

$$\eta O \propto \frac{0.4129}{16} \text{ or } 0.0258$$

The above quotients can be reduced to whole numbers of atoms either through division of each by their highest common factor*—the traditional method—or by multiplication of each by the least quantity that will yield whole numbered products—Stone's method (*1*). It is easily seen that this choice of operations is due to the equivalence of division and multiplication when the divisors and multipliers are reciprocals. In our example, it is evident that

$$\eta Ca = \frac{0.00645}{0.00645} = 1$$

$$\eta C = \frac{0.0129}{0.00645} = 2$$

$$\eta O = \frac{0.0258}{0.00645} = 4$$

Also, although the multiplier is not so readily apparent,

$$\eta Ca = 0.00645 \times 115 = 1$$
$$\eta C = 0.0129 \times 115 = 2$$
$$\eta O = 0.0258 \times 115 = 4$$

Identical results are obtained by following the general outline of Stone's method (*1*). Thus on the basis of carbon, the molecular weight of the compound is represented by $\frac{12}{0.1548}$ or 77.51

Then

$$\text{Weight Ca} \propto 77.51 \times 0.2581 \text{ or } 20$$
$$\text{Weight C} \propto 77.51 \times 0.1548 \text{ or } 12$$
$$\text{Weight O} \propto 77.51 \times 0.4129 \text{ or } 32$$

$$\eta Ca \propto \frac{20}{40} \text{ or } 0.5$$
$$= 0.5 \times 2 \text{ (or } \div 0.5) = 1$$

$$\eta C \propto \frac{12}{12} \text{ or } 1$$
$$= 1 \times 2 \text{ (or } \div 0.5) = 2$$

$$\eta O \propto \frac{32}{16} \text{ or } 2$$
$$= 2 \times 2 \text{ (or } \div 0.5) = 4$$

* Although many textbooks direct that such quotients be divided by the smallest of them, this procedure often leads to further fractions and thus necessitates an additional operation. This complication does not arise when the divisor is the H. C. F. The smallest quotient is of course frequently also the H. C. F.

While the foregoing solutions demonstrate that formulas can readily be computed from weights, the author does not advocate that this method supersedes those which proceed from a percentage basis, for a formula would not rest very securely on the results of a single analysis. On the contrary, the purpose of this discussion is to demonstrate the fundamental relation of these methods to analytical data, and thereby to provide a means of counteracting the all-too-frequent tendency of pupils—and students likewise—to miss the chemical significance of the arithmetical operations involved in the calculation of formulas.

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(1) STONE, "A Question of Procedure," J. CHEM. EDUC., 5, 465–6 (Apr., 1928).

X-Rays May Improve Useful Plants. A new tool of importance in the control of agricultural production of the future, may be in the use of X-rays or similar shortwave vibrations, Dr. W. W. Garner, of the U. S. Dept. of Agriculture, believes.

Experimentation in this field is so new that some of the most striking effects have not been followed far enough to reveal their ultimate results. Wild corn plants appear to have been changed from annuals to perennials at Cornell University by treating the seeds with X-rays. And in accordance with experiments elsewhere, the evidence seems to be that under suitable conditions, X-rays do bring about a mutation.

The scientist may therefore be able to take some sort of hand in plant evolution. The importance this could have on crop production cannot be over-estimated, Dr. Garner said. However, the future will show to what extent this new tool can be effectively applied in crop improvement.

Work along these lines upon plants is being done at the Universities of Missouri and California, while at the University of Texas, the effect of X-rays on the progeny of certain flies has been studied.—*Science Service*

Chemicals Open Up Pores of Wood. Treatment with chemicals opens up the pores of some kinds of timber. In a report to the American Chemical Society, A. J. Stamm, of Madison, Wis., explained how chlorine gas was used on specimens of Douglas fir and Sitka spruce. Measurements revealed that the chlorine, which was followed in some instances by ammonia, acted on the capillaries, the little hair-like tubes in the wood, and opened them up. This was thought due to dissolving of the lignin, the substance that lines the woody cells and causes resistance to the flow of liquids. The use of chlorine gas was found to increase the passage of materials through the wood by as much as 130 times.—*Science Service*

Practicable to Use Blast Furnace for Fertilizer Making. Use of the blast furnace to prepare phosphoric acid for fertilizer purposes was sanctioned in a report given at the fall meeting of the American Chemical Society. Smelting tests lead to the conclusion that the method is economically practicable. It was brought out in this report, prepared by P. H. Royster and J. W. Turrentine, that in any furnace process more than two-thirds of the cost of the finished product is the cost of coke used as fuel. Low-cost phosphoric acid means an efficiently operating furnace. The factor most important to an efficient blast furnace is the preheating of the air to a high temperature before introducing it into the furnace. The grade of phosphate rock, it was pointed out, does not affect the heat production or influence the consumption of coke.—*Science Service*

A TABLE OF SOLUBILITIES AND COLORS OF PRECIPITATES FOR USE IN A COURSE IN QUALITATIVE ANALYSIS

WAYNE E. WHITE, WESTERN RESERVE UNIVERSITY, CLEVELAND, OHIO

A chart is presented, showing the colors and qualitative solubilities of precipitates obtained by the interaction of each of the cations usually included in an elementary course of analysis with each of the anions. Some further information is given in notes.

. . . . . .

The student in an elementary course in qualitative analysis can often get aid in his work by referring to the solubility table which is generally incorporated in the text or direction pamphlet used as a guide for his analysis. In the belief that such a table can be made even more helpful by including the color of the precipitate—in cases where the substance is insoluble enough to form one—the chart herein presented has been worked out by the author and some students working under his direction.

Although each compound described in this chart has probably been previously investigated and reported upon, it was thought better actually to make all of the tests indicated rather than simply to use such information as might be found in the literature. This procedure assured similarity of technic and of concentration conditions throughout; such would not have been the case had the work been a summation of the findings of many investigators. Many of the texts of qualitative analysis and inorganic chemistry have been used as references, however, and when experimental findings disagreed with those reported, effort was made to reconcile the two.

The solutions given out for qualitative analyses are generally of such concentrations that each ion is approximately one-half normal. Consequently the solutions used in this work were made up of that concentration except in the case of the oxalate ion. Sodium oxalate is not soluble enough to give a solution one-half normal in respect to the anion. The usage of solutions of equal normality has the further advantage of making it an easy matter to get equivalent quantities of the two ions whose interaction is under observation. This is important in cases where a precipitate is soluble in excess cation or anion solution.

It must be emphasized that this table shows what happens when one mixes equal volumes of solutions of one-half normal concentration of the ions indicated and it shows something of the properties of the product if there is interaction. This product is *not necessarily* a compound formed by the combination of the two ions, or it may not be a simple compound arising from their combination. For example, the table shows that the aluminum and cyanide ions combine to give a white precipitate soluble in acid. This white precipitate, however, is not the cyanide but aluminum hydroxide. And so it is in many cases.

In the chart the colors of the precipitates are given by the upper symbols in each rectangle. The symbols are derived from the words repre-

	OH^-	CO_3^{--}	$C_2O_4^{--}$	$C_4H_4O_6^{--}$	CN^-	CNS^-	$Fe(CN)_6^{----}$	$Fe(CN)_6^{---}$	Cl^-	Br^-	I^-	ClO_3^-
Ag^+ [1]	Br a	W→Y a	W a	W a	W^{10} I	W I	W I	O I	W I	W, Y I	Y I	. . . .
Pb^{++} [1]	W^{10} a	W a	W a	W a	W a	W^7 a	W a	W a	W a	W a	Y A	. . . .
Hg^+ [1]	G a	G a	W A	W a	G A	G I	W I	Y, Gr I	W I	W, Y I	Gr, Y I^{10}	. . . .
Hg^{++}	Y a	R, Br a	W a	W a	. . . .	W^{10} a	W, Y a	Gr a	. .	Y, W a^{10}	O^{10} A	. . . .
Cu^{++}	Bl a	Bl a	Bl^{10} A	. . . .	Y, Gr A^{10}	B→W I	R, Br I	Gr I	.	.	G I	. . . .
Cd^{++}	W a	W a	W a	W W	W^{10} a	. . . .	W^9 a	Y^9 a	. .	. .	. .	. . . .
Bi^{+++} [2]	W a	W a	W A	. . . .	W a	. . . .	W a	Y, Br a	W a	W A	Br, B A^{10}	. . . .
Sb^{+++} [2]	W^{10} a	W a	W a	W a	W^{10} a	. . . .	W I	. . . .	. . . .	. . . .	Y→O a	. . . .
Sn^{++}	W^{10} a	W a	W^{10} a	W a	W a	W a	W A	W A	. . . .	W W	W, Y a	. . . .
Sn^{++++}	W^{10} a	W a	. . . .	W a	W a	. . . .	Y I	Gr I	. . . .	. . . .	. . . .	. . . .
Fe^{++}	W→Gr a	W→Gr a	Y, Gr a	. . . .	Br I	. . . .	Bl, W I	Bl I	.	. .	. . . .	. . . .
Fe^{+++}	R, Br a	R, Br a	. . . .	. . . .	R, Br a	. . . .	Bl I	. . . .	.	. .	. . . .	. . . .
Al^{+++}	W^{10} a	W a	. . . .	. . . .	W a	. . . .	.	. . . .	.	. .	. .	. . . .
Cr^{+++}	Gr^{10} a	Gr a	Gr a	Gr a	Gr a	. .	Gr A	. . . .	. .	. .	. .	. . . .
Ni^{++}	W, Gr a	W, Gr a	W,Gr a^7	. . . .	Y, Gr A^{10}	. . . .	W, Gr I	G→Br I	. . . .	. . . .	. . . .	. . . .
Co^{++}	Bl→Gr a	P a	P^7 a	. . . .	P, Br A^{10}	. . . .	G, Gr I	Br, R I	. . . .	. . . .	. . . .	. . . .
Mn^{++}	W→Br a	W a	W^7 a	. . . .	W→Br a	. . . .	W→Br A	Br I	. . . .	. . . .	. . . .	. . . .
Zn^{++}	W^{10} a	W a	W a	. . . .	W^{10} a	. . . .	W I	Br, Y A	. . . .	. . . .	. . . .	. . . .
Ba^{++}	. . . .	W a	W a	W W	W a	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .
Sr^{++}	W W	W a	W a	. . . .	W a	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .
Ca^{++}	W W	W a	W a	. . . .	W W	. . . .	W^7 a	. . . .	. . . .	. . . .	. . . .	. . . .
Mg^{++}	W a	W a	W^7 a	. . . .	W a	. . . .	W^7 W	. . . .	. . . .	. . . .	. . . .	. . . .
K^+	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .
Na^+	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .
NH_4^+	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .
H^+ [3]	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .

(The numbers in this chart refer to the notes on page 2250.)

COLOR is shown by the upper letters in each rectangle.

B = black, Br = brown, Bl = blue, G = gray, Gr = green, Y = yellow, O = orange, P = pink, R = red, W = white, and . . = no precipitate.

NO_2^-	NO_3^-	$^4BO_2^-$	$C_2H_3O_2^-$	$^5AsO_3^{---}$	$^5AsO_4^{---}$	CrO_4^{--}	$^5PO_4^{---}$	SiO_3^{--}	$^6S^{--}$	$S_2O_3^{--}$	SO_3^{--}	SO_4^{--}
W	..	W	..	Y	R, Br	R	Y	R	B	W→B	W^{10}	W
W	..	a	..	a	a	a	a	a	A	A^{10}	a	a
W	..	W	W	W	W	Y	W	W	B	W^{10}	W	W
W	..	a	a	a	a	a	a	a	A	a	a	I
G	..	G	W	W→G	W	O, R	W	G	B	G, B	B→G	W
I	..	a	W	a	A	I	a	a	I	I	A	a
..	..	Y	..	Y, Gr	Y	O	W	Y	B	Y, Br	W	W, Y
..	..	a	..	A	a	a	a	a	I	I	a	a^8
..	..	Bl	..	Gr	W, Bl	R, Br	Bl, Gr	Bl	B	..	Gr, Y	..
..	..	a	..	a	a	a	a	a	I	..	a^{10}	..
..	..	W	..	W	W	..	W	W	Y^9	..	W	..
..	..	a	..	a	a	..	a	a	a	..	a	..
..	..	W	W	W	W	O, Y	W	W, Y	Br, B	..	W	W
..	..	a	a	a	a	a	a	a	A	..	a	a
..	..	..	..	..	..	W	..	..	O	..	..	..
..	..	..	..	..	..	A	..	..	A	..	..	..
W	..	W	W	W	W	Br→Gr	W	..	Br	W^{10}	W	W
a	..	a	a	a	a	a	a	..	A	a	a	a
W	..	W	W	W	W	Y	W	W	Y	..	W	W
a	..	a	a	a	a	a	A	a	A	..	a	a
..	..	Gr	..	Gr	Gr	Br	W	W→Gr	B	..	Gr	..
..	..	a	..	a	a	a	a	a	a	..	a	..
..	..	..	.	Y, Br	W	O	Y	Y	Br, B	..	..	..
..	..	..	..	a	a	a	a	a	a	..	..	..
..	..	W	..	W	W	O	W	W	W	..	W	..
..	..	a	..	a	a	a	a	a	a	..	a	..
..	..	Gr	..	Gr	Gr	Y, Br	Gr	Gr	Gr	Gr	Gr	Gr
..	..	a	..	a	a	a	a	a	a	a	a	a
..	..	W, Gr	.	W, Gr	W, Gr	Y^7	W, Gr	W, Gr	B	..	W, Gr	..
..	..	a	.	a	a	a	a	a	A	..	W	..
..	..	P	.	P	P	Br^7	Bl, P	Bl, P	B	..	P^{10}	..
..	..	a	.	a	a	a	W	a	A	..	W	..
..	..	W	..	W	W	Br	W	W	W, P	..	..	..
..	..	a	..	a	a	a	a	a	a	..	..	..
..	..	W	..	W	W	Y	W	W	W	..	W	..
..	..	a	..	a	a	a	a	a	a	..	a	..
..	..	W	..	W	W	Y	W	W	W	..	W	W
..	..	W	..	a	W	a	a	a	a	..	a	I
..	..	W	..	W	W^7	Y	W	W	W	..	W	W^7
..	..	a	..	a	W	a	a	a	a	..	a	A
..	..	W	..	W	W	..	W	W	..	..	..	..
..	..	W	.	a	W	..	a	a	..	..	..	..
..	..	..	..	W	W	..	W	W	W	..	..	..
..	..	..	..	a	a	..	a	a	a	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	W	..	..	..	..	..	W	..	..
..	..	..	..	a	..	..	..	..	..	I	..	..

SOLUBILITY is given by the lower letters.

.. = no ppt. W = the ppt. dissolves in excess water. a = insoluble in water but soluble in dilute acid. A = insoluble in dilute but is soluble in concentrated acid. I = insoluble in water, in dilute, and in concentrated acid.

sented by taking the first one or two letters. Occasionally a precipitate which changes color on standing is formed. In such a case the change is indicated by the arrow. For example, the silver ion with the carbonate ion gives a white precipitate which changes to brown. This is shown by W $\longrightarrow$ Br.

The meaning of the terms used in describing the solubilities is best shown, perhaps, by a brief discussion of the procedure used in the tests. About 3 cc. of the anion solution was added to the same volume of cation solution in a test tube. If no precipitate appeared, even on standing for five minutes, that test was recorded in the table by the dots. If, on the other hand, a precipitate was obtained it was said to be soluble in water (indicated by W) if a small portion of it dissolved in a test tube (about 25 cc.) full. If it was not soluble in excess water then approximately a third of the original precipitate was treated with 10 cc. of 2 *N* hydrochloric acid. A dissolution was recorded in the table by *a*. (As shown in the notes nitric acid was used instead of hydrochloric in some cases.) If the precipitate did not dissolve in the dilute acid but did under the same conditions when the concentrated acid was used, the symbol *A* was used. *I* was used to show that the substance did not dissolve in water, in dilute or in concentrated acids. In many cases the solubility in excess of the anion solution was tested also.

Notes Appended to the Chart

1. Nitric acid was used for solubility tests.

2. White precipitates of the basic salts form easily when the acid concentration is reduced sufficiently by the addition of water or of anion solution. Precipitates are recorded in the table, however, only when it was believed that the precipitate was a substance other than the basic salt.

3. The H^+ ion was from $N/2$ HNO_3.

4. The solution used for this ion was one of sodium tetraborate and may contain the orthoborate ion as well as the metaborate.

5. The acid salts, Na_2HAsO_3, Na_2HAsO_4, and Na_2HPO_4, were used for these ions. Some of the precipitates may be from the combination with the ions, $HAsO_3^{--}$, etc.

6. This ion was obtained from a solution of Na_2S.

7. The precipitate does not appear immediately, but in 15 seconds to five minutes.

8. There is no precipitate in the presence of the Cl^- ion.

9. The precipitate is more readily soluble in HCl than in HNO_3.

10. The precipitate is soluble in excess anion solution.

Do you covet honor? You will never get it by serving yourself. Do you covet distinction? You will get it only as a servant of mankind. Do not forget then, as you walk these classic places, why you are here. You are not here merely to prepare to make a living. You are here in order to enable the world to live more amply, with greater vision, with a finer spirit of hope and achievement. You are here to enrich the world, and you impoverish yourself if you forget your errand.—WOODROW WILSON

REACTION CHARTS

R. H. Crist, Columbia University, New York City

The chemistry of some of the non-metallic elements presents a confusing variety of reactions to the student of inorganic chemistry. Interesting and important correlations cannot be made because of the difficulty in keeping the details in mind. It was this situation which led to the construction of the charts herein presented. They have been used successfully for some years.

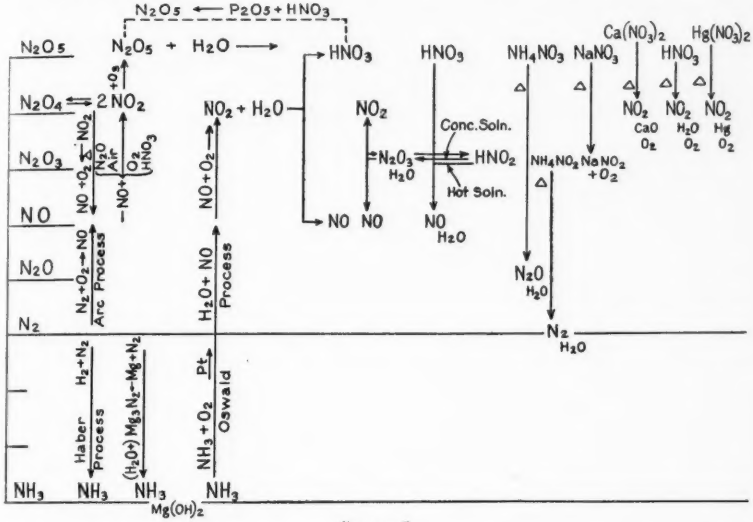


Chart I

The charts are for the most part self-explanatory. Equations have been left unbalanced for the sake of simplicity. Some interesting observations can be pointed out in the reactions of the halogen compounds of which

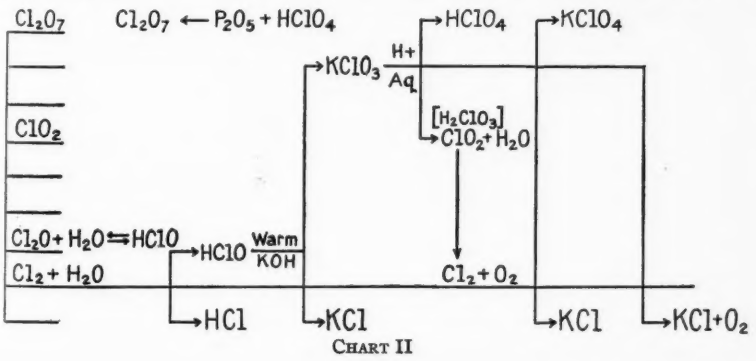


Chart II

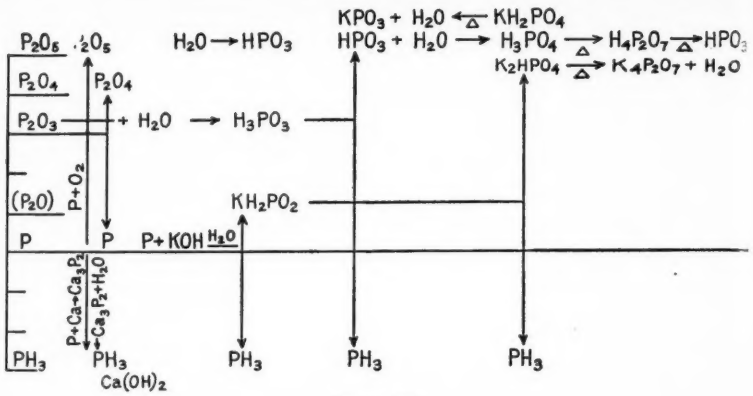
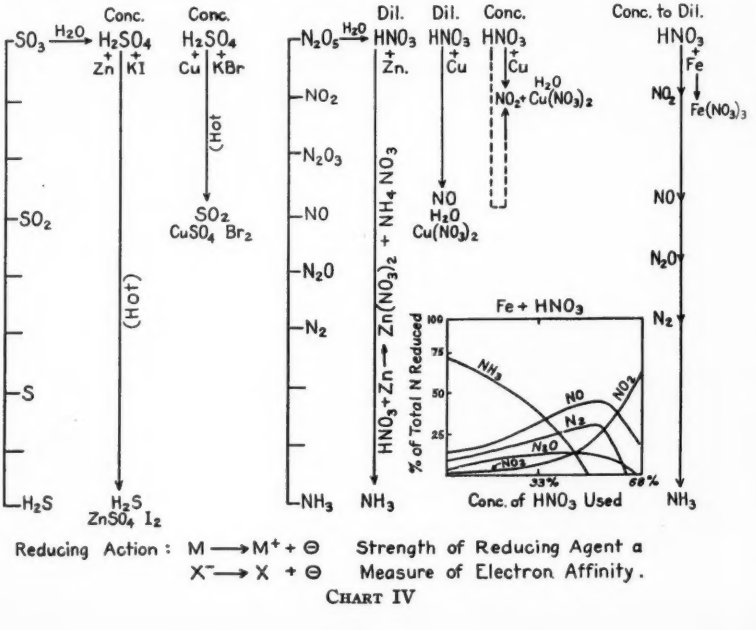


CHART III

those in the chart for chlorine are typical. The compounds found in nature are those with a valence of -1 or of $+7$. The instability of the compounds intermediate to these two stable varieties is apparent from the chart. These phenomena can be interpreted structurally from the stability of the rare gas configurations represented by the respective stable compounds.



Reducing Action: $M \longrightarrow M^{+} + \ominus$ Strength of Reducing Agent a
$X^{-} \longrightarrow X + \ominus$ Measure of Electron Affinity.

CHART IV

The sulfur reactions analogous to those of $KClO_3$ and $HClO_3$ are

$$Na_2SO_3 = Na_2S + Na_2SO_4$$

and

$$H_2SO_3 = H_2SO_4 + S + H_2O$$

The compounds of phosphorus act similarly to the halogen compounds and sodium sulfite.

An attempt is made in the chart for oxidation-reduction processes with sulfuric and nitric acids to show the effect of the various reducing agents. It should be pointed out that H_2S, for example, is not the sole reduction product of KI and concentrated H_2SO_4. Some SO_2 and free sulfur are also likely to be present. The inset for iron and nitric acid shows the proportions of the various reduction products of nitric acid for the different concentrations of the acid used (*1*).

Literature Cited

(*1*) BROWN, J. G., *J. Phys. Chem.*, **25**, 431 (1921).

Brazilian Wood Causes Poisoning Like Ivy. Cases of skin poisoning among woodworkers, similar in many respects to the effects of poison ivy or poison oak, have been investigated by the U. S. Public Health Service, which has just reported its findings.

The trouble has been due to a hardwood imported from Brazil. In its native land, the wood is known as "embuia"; in America it is given the trade name of Brazilian walnut, though it is not a true walnut but a relative of the laurel. It is highly prized as a material for fine woodwork in Brazil.

"Patch tests" given by applying sawdust from the wood to selected skin areas on human volunteers definitely determined its guilt. Not all persons are susceptible, however, and susceptible persons often acquire immunity.

During the war, Brazilian walnut was imported to some extent for use in rifle stocks, but at that time no trouble was reported.—*Science Service*

New Source of Rare Metal Found. A new source of the recently discovered metal rhenium, which contains up to one per cent of rhenium, has been announced by its discoverers, Dr. Walter Noddack and his wife, Dr. Ida Noddack.

Previously the best ore from which the new metal could be obtained contained only one part of the metal in 660,000 of the ore. Dr. Walter Noddack has been seeking a more plentiful source of the metal for several years.

Rhenium, number 75 in the order of the elements, which was discovered a few years ago, is chemically similar to the common element manganese with which it often occurs in minerals.

Several thousands of tons of rhenium and rhenium compounds have been distributed among scientists throughout the world. They will study the properties of the new element on a larger scale than hitherto.—*Science Service*

Find Zinc in Drinking Water. As much zinc as 50 parts per million of water is found in natural waters of the Missouri-Kansas-Oklahoma zinc district. Animals and humans are drinking it. Zinc in that proportion in the form of zinc sulfate had no bad effect when tried on rats. The problem was discussed before the American Chemical Society meeting at Buffalo by Prof. Edward Bartow of the University of Iowa. If pure zinc is used in galvanizing iron pipes for drinking water, less zinc will be dissolved, he said.—*Science Service*

MOTOR STIRRING APPARATUS

G. Ross Robertson, University of California at Los Angeles, California

The lack of an inexpensive electric stirrer in the chemical apparatus market has led several large laboratories to draft into service the comparatively new "household mixer" of commerce. This device, widely sold at a very low price, is readily adapted to laboratory use by direct rubber tube connection of its vertical shaft with an ordinary glass stirring paddle. Its universal motor permits rheostat speed control. To be sure, it becomes warm when operated at reduced speeds; but no serious damage seems to occur even after weeks of prolonged duty at moderated speed. Quite naturally, however, the household stirrer is assembled in a manner better adapted to eggs and mayonnaise than to the chemical laboratory.

It is both expensive and awkward to provide such a motor with the customary large laboratory rheostat on a student's desk. Furthermore, the open wiring to 110-volt service near wet plumbing is unsafe. These considerations have led us to combine the household stirrer with a very small rheostat and electrician's conduit fittings to give a compact outfit without electrical hazard to inexperienced users. Figure 1 illustrates the arrangement, including the following parts:

One Polar Cub Household Mixer complete with switch, cord, plug, and steel stirring paddle	$5.00
One Allen-Bradley Bulletin 410 Size A Controlling Rheostat, switchboard model, range 8 to 600 ohms	3.00
One standard zinc-plated pressed steel conduit switchbox, single, with plain cover	.30
One galv. pipe nipple, 1/2" I. P., 8" long	.15
One plumbers' waste-nut, 1/2" I. P.	.10
One pipe bushing, inch-to-half-inch I. P.	.10
One laboratory clamp holder, large size	.30
Screws, nuts	.05
List retail	$9.00
Deducting customary discounts to educational institutions, total cost of material (approx.)	$7.25

A mechanics' helper can assemble the outfit in less than half a day, bringing the total cost to less than $10. The wooden handle furnished with the motor is replaced with the pipe bushing which is turned or ground down slightly to fit the motor ferrule.

While the compression rheostat specified is a compact and rugged device, even more economical substitutes are available at radio supply stores under the name of "power potentiometers." These list at $1.50 up, and are wire rheostats with knob handle; for example, the De Jur Power Potentiometer and the Truvolt Variable Resistance. Novelties in this line appear in the market frequently. The 0–500 ohm size seems to be the best commercially available at the present writing. A slightly higher resistance than 500

ohms is desirable for very slow speed on very light load, but the commercial radio potentiometers of higher resistance have scarcely enough carrying capacity (0.2 ampere) to control the stirrer safely.

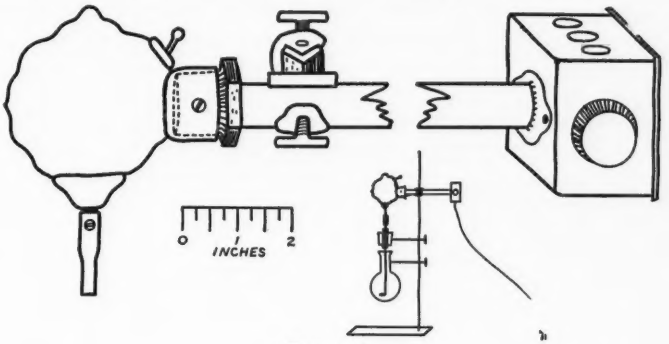


FIGURE 1

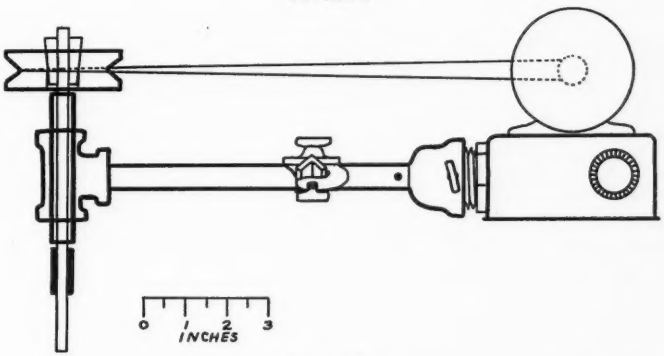


FIGURE 2

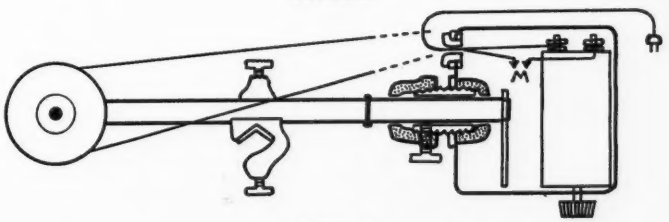


FIGURE 3

The compression rheostat is capable of handling considerably more than 0.2 ampere provided the power consumption in the device does not exceed 20 watts. Tests in this laboratory show that neither the Polar Cub (Figure 1) nor the 1/200 h.p. motor (Figures 2, 3) place a burden of more

than 12 watts on the rheostat at peak rheostat load. This peak load occurs at intermediate speed. The rheostat uses as little as 5 watts at high and low speeds. On the other hand, the effective resistance of this type of rheostat changes slightly with temperature, necessitating a small readjustment of speed after the appliance becomes warm.

The principal shortcoming of the above equipment is lack of power at low speeds. In most operations by students this is of little concern, as the experimenter merely turns the knob until he gets the desired effect. For higher power at low speed, and thus at constant speed on light load, the assembly shown in Figures 2 and 3 gives good service. While more expensive than the device of Figure 1, it is still far cheaper than the standard laboratory stirring motor.

The motor is a stock 1/200 (or 1/150) h.p. universal motor, which is the smallest standard model of the major manufacturers. It is more expensive and more efficient than the Polar Cub, and gives additional power at nearly the same current consumption. It is designed for horizontal operation. With the belt drive ratio of 4 to 1, the stirrer is very effective on heavy loads. The motor carries a V-groove pulley furnished by the manufacturer.

A General Electric motor used in this assembly consumes only 0.2 ampere at common speeds; 0.35 ampere with locked rotor and 112 volts A. C. directly across the terminals. Westinghouse and other manufacturers offer equipment of much the same class and cost.

The motor is mounted on the bottom of a conduit outlet box (4 × 4 inches), in which the superfluous circular knockouts have been hammered back into place and soldered over a Bunsen flame in places where they are called upon to support a screw. The box encloses the rectangular Bradley rheostat of the same size used in the apparatus of Figure 1. The pipe in this assembly is made as short as possible to minimize overhang in the back. It is of $^3/_8$″ I. P. size, and slips loosely through the two $^3/_4$″ caps which are drilled and mounted on a $^3/_4$″ close nipple fastened to the box. The right end of the pipe is screwed into a small rectangular piece of flat iron bar which prevents it from turning in the box, but permits the box to slide back and forth slightly for adjustment of belt tension.

The pulley (2″ running diameter, four times that of the motor) is mounted on a suitable length of $^1/_4$″ brass rod which rotates in a reamed bearing made from a piece of $^1/_2$″ brass rod. The brass bearing is threaded externally $^1/_2$″ S. A. E., and screwed down clear through the straight run of the tee; or it may simply be soldered into the tee, as suggested in the figure. A standard $^3/_8$″ to $^1/_4$″ bull head tee is used. Common stout twine serves as belt material.

In either of these pieces of apparatus it is desirable to provide a laboratory clamp holder of a size just large enough to slip readily along the pipe, but not large enough to be taken off. The holder thus becomes a permanent part of the outfit as issued at a storeroom.

LABORATORY APPARATUS FOR ILLUSTRATING GRAHAM'S EFFUSION LAW

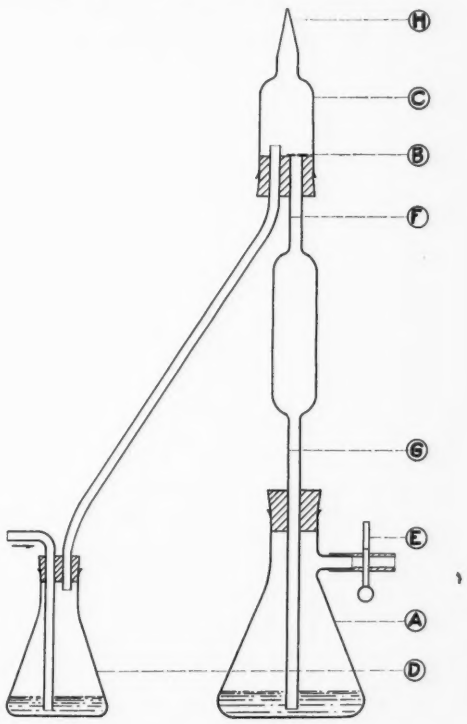
PAUL EMIL WENAAS, MONTANA STATE COLLEGE, BOZEMAN, MONTANA

The construction and the use of an apparatus illustrating Graham's Effusion Law is described. It can be easily constructed of ordinary laboratory equipment. Its advantage lies in its ease of replacement of parts in case of breakage and the elimination of corrections necessary in some types of apparatus.

Use of the apparatus by students in physical chemistry at Montana State College, Bozeman, Montana, has shown that the apparatus can be easily manipulated, the experimental results of molecular weights obtained checking in some cases very closely with the true values.

. . . . . .

An apparatus illustrating Graham's Effusion Law which can be easily constructed of ordinary laboratory equipment has been successfully used in the physical chemistry laboratory of the chemistry department at Montana State College. Its advantage lies in its ease of replacement of parts in case of breakage and the elimination of corrections for moisture necessary in some types of apparatus.



It consists of a filter flask, *A*, equipped with a one-hole rubber stopper and a 50-cc. pipet. To the pipet is attached a two-hole rubber stopper. Over the hole in the stopper connected with the pipet is sealed with sealing wax a thin metal plate, *B*, with a very small opening. Sheet aluminum or sheet copper can be very conveniently used for this purpose. A needle which has been filed to give a long narrow point is used to make the opening in the plate. In place of the metal plate, a piece of glass tubing drawn to a small opening on one end may be inserted in the same hole in the stopper. This, however, must be so constructed that the length of the narrowed

part is the minimum possible, in order to eliminate capillary action. An inverted Gooch filter, *C*, is placed over the rubber stopper. The opening at *H* must be made small enough to maintain a slight positive pressure in *C*, either by drawing out *H* or by placing a piece of small rubber tubing over the top of the inverted filter. A piece of glass tubing connects the second hole in the stopper with an Erlenmeyer flask, *D*, containing sulfuric acid to dry the gas used. Good connections must be used throughout to eliminate errors due to leaks.

The gas from the supply streams through the drying flask and the Gooch filter to displace all of the air in the apparatus. During this time the sulfuric acid in the filter flask is forced up the pipet nearly to the lip and suddenly released by opening the pinch clamp, *E*. This is repeated until all of the air is out of the apparatus; then it is repeated and the time necessary for the acid level to pass from *F* to *G* is measured with a stop-watch.

Use of the apparatus by students showed that the flow of gas should be so regulated that it enters *D* at the rate of two bubbles per second. A greater rate of flow is, however, not objectionable as long as the opening *H* is large enough to equalize the pressure inside the Gooch filter and the pressure of the atmosphere. A too-small rate of flow will allow air to enter *H*, contaminating the gas being used and introducing errors in the experiment. It is recommended that the opening in the metal plate or in the glass tube be so adjusted that the time for oxygen is between 80 and 110 seconds.

With oxygen used as a standard, the molecular weights of nitrogen, carbon dioxide, air, and hydrogen were observed, and agreed with the true molecular weights within 0.75 to 2.09%.

New Methods Detect Iodine in Soils. New methods, of unprecedented delicacy, for determining the amount of iodine in rocks and soils were described before the meeting of the American Chemical Society by Prof. J. S. McHargue and W. R. Roy, of the Kentucky Agricultural Experiment Station, and by Dr. George M. Karns of the Mellon Institute. The methods described by Prof. McHargue and Mr. Roy make it possible to measure iodine in the soil when there is as little present as one part in two millions. Soil analysis for iodine has assumed considerable importance in agricultural chemistry since the usefulness of that element in preventing goiter was discovered.—*Science Service*

Scattered Light in Liquid Reveals Its Molecular Structure. The scattered rays of light caused when a beam is passed through a liquid are useful in studying the molecular structure of compounds and their identification. This is a secondary light emitted by the liquid in all directions, Prof. Donald H. Andrews of the Johns Hopkins University explained to fellow scientists at the recent meeting of the American Chemical Society, and its frequency is different from that of the original beam. The rate of vibration depends on that of the atoms in the molecules that do the scattering. For that reason they can disclose the nature of those molecules.—*Science Service*

DOCTORATES IN CHEMISTRY AND RELATED FIELDS CONFERRED BY AMERICAN UNIVERSITIES, 1930–31

COMPILED BY CLARENCE J. WEST AND CALLIE HULL, RESEARCH INFORMATION SERVICE, NATIONAL RESEARCH COUNCIL, WASHINGTON, D. C.

The Research Information Service of the National Research Council again offers the following statistics concerning the doctorates in chemistry and related fields conferred by American universities during the academic year 1930–31. This is the seventh year in which this compilation has been made; previous lists have been published in the JOURNAL OF CHEMICAL EDUCATION, **3,** 77–99 (Jan., 1926); **4,** 99–109 (Jan., 1927); **4,** 1303–13 (Oct., 1927); **5,** 1450–63 (Nov., 1928); **6,** 2209–23 (Dec., 1929); **7,** 2966–82 (Dec., 1930).

In this compilation the doctorates granted by the universities in agricultural chemistry, biochemistry, engineering, and metallurgy have been listed under the separate headings but are included in the totals by university in the statistical tables. In selecting the titles to be included, those doctorates have been used, which, if published, would probably be abstracted in *Chemical Abstracts*. Attention is again called to the fact that the compilers have only the title of the thesis and, in most instances, the department in which the doctorate was granted, to aid them in the subject classification. It is not always possible to classify correctly from this information, which may account for the inclusion or the omission of a given thesis. Corrections and suggestions as to this publication are always appreciated.

There are nineteen universities which report ten or more doctorates in chemistry and related subjects during the past academic year, a gain of four over last year. Ohio State University assumes the lead this year with 39 doctorates, with Wisconsin a close second with 38 doctorates. Columbia and Cornell tie for third place, each having granted 26 doctorates; Cornell advances from tenth place last year to fourth place this year. Illinois and Yale also are tied, each with 25 doctorates. New members of this group are New York University, Harvard, Stanford, Cincinnati, and Maryland. In this connection it must be remembered that an examination of the dissertations probably would make a difference in this table, since some of the titles of doctorates give no clue as to their contents. It is also true that some of the doctorates granted in physics might properly be included in this list, with as much justification as we now include some of the doctorates in biochemistry. The order given above is, therefore, relative only but it still is an indication of the amount of graduate study being carried on at these institutions.

Information concerning all the doctorates granted in the sciences (1147 for the year 1930–31) will appear in a forthcoming number of the Reprint and Circular Series of the National Research Council (No. 101), copies of which may be obtained from the Publication Office.

TABLE I

Distribution of Doctorates in Chemistry by University, by Year

Institution	'22–'23	'23–'24	'24–'25	'25–'26	'26–'27	'27–'28	'28–'29	'29–'30	'30–'31
American	..	..	..	1	1	1	..	3	3
Boston	1	..	..	1	..	..	..	1	..
Brown	..	..	5	2	2	4	4	6	4
Bryn Mawr	..	..	..	..	1	..	1	..	..
California	11	6	8	7	16	9	13	15	13
Calif. Inst. Tech	..	3	4	7	..	6	4	4	5
Catholic	1	2	2	1	3	1	2	1	1
Chicago	12	19	14	26	21	19	24	37	22
Cincinnati	1	2	4	4	3	..	8	4	10
Clark	3	3	..	..	..	..	..	..	..
Colorado	1	..	1	2	1	3	3	..	2
Columbia	28	35	30	34	28	23	25	18	26
Cornell	8	19	14	12	16	21	15	15	26
Duke	..	..	..	..	..	..	4	2	3
Fordham	2	..	2	2	1	2	8	4	4
Geo. Washington	6	3	1	2	2	1	3	..	2
Harvard	5	18	13	10	11	8	7	8	12
Illinois	19	19	18	18	11	16	16	24	25
Indiana	2	1	2	2	2	2	3	3	3
Iowa	4	3	6	10	9	16	13	12	16
Iowa State	..	4	7	8	7	13	13	12	24
Johns Hopkins	12	12	10	19	15	17	21	21	16
Kansas	..	1	3	1	5	3	5	5	..
Maryland	..	..	..	4	2	3	2	2	10
Mass. Agr. Coll	1	..	..	..	..	..	..	..	..
Mass. Inst. Tech	6	11	17	8	6	7	11	12	13
Michigan	2	11	2	13	8	8	13	15	11
Mich. State Coll	..	..	..	1	..	..	..	1	3
Minnesota	3	9	8	8	8	15	15	16	17
Missouri	..	1	1	1	1	2	1	1	2
Nebraska	1	3	3	1	1	..	1	2	4
New York	6	1	3	2	3	6	4	7	13
N. Y. State Coll. For	..	..	..	..	..	1	..	..	..
North Carolina	1	..	..	5	2	4	2	1	7
Northwestern	..	4	1	1	3	5	3	7	8
Notre Dame	1	2	..	..	..	..	1	3	2
Ohio State	13	14	23	11	15	11	19	22	39
Pennsylvania	..	4	1	7	7	3	3	7	7
Penna. State	..	..	..	..	..	4	3	3	8
Pittsburgh	6	5	7	3	10	9	7	11	6
Princeton	2	8	4	4	4	8	7	5	2
Purdue	..	..	..	..	..	..	..	2	2
Radcliffe	..	..	..	..	..	1	1	..	1
Rensselaer	..	..	..	..	..	3	1	1	2
Rice	..	..	1	..	1	1	1	2	..
Rochester	..	..	1	..	2	3	..	2	4
Rutgers	..	..	..	..	..	1	3	5	4
St. Louis Univ	..	..	..	..	2	1	1	1	3

TABLE I—*Continued*

Institution	'22–'23	'23–'24	'24–'25	'25–'26	'26–'27	'27–'28	'28–'29	'29–'30	'30–'31
Stanford	3	8	2	5	3	3	9	8	11
State Coll. Wash.	..	..	..	..	..	..	..	..	1
Syracuse	..	..	..	..	2	1	..	2	1
Texas	..	..	..	..	..	..	..	1	..
Tulane	..	..	..	..	1	..	..	..	..
Virginia	1	2	3	2	3	2	3	4	2
Wash. U., St Louis	1	..	..	..	2	..	2	1	1
Washington	..	1	2	..	1	1	4	2	3
Western Reserve	..	..	..	..	..	..	..	3	8
Wisconsin	14	21	26	24	16	25	31	27	38
Yale	17	8	16	18	12	19	19	24	25
TOTAL	194	263	265	287	270	312	359	394	465

TABLE II

Universities Granting 10 or More Doctorates in Chemistry, 1930–31

Institution	'22–'23	'23–'24	'24–'25	'25–'26	'26–'27	'27–'28	'28–'29	'29–'30	'30–'31
Ohio State	13	14	23	11	15	11	19	22	39
Wisconsin	14	21	26	24	16	25	31	27	38
Columbia	28	35	30	34	28	23	25	18	26
Cornell	8	19	14	12	16	21	15	15	26
Illinois	19	19	18	18	11	16	16	24	25
Yale	17	8	16	18	12	19	19	24	25
Iowa State	..	4	7	8	7	13	13	12	24
Chicago	12	19	14	26	21	19	24	37	22
Minnesota	3	9	8	8	8	15	15	16	17
Iowa	4	3	6	10	9	16	13	12	16
Johns Hopkins	12	12	10	19	15	17	21	21	16
California	11	6	8	7	16	9	13	15	13
Mass. Inst. Tech.	6	11	17	8	6	7	11	12	13
New York	6	1	3	2	3	6	4	7	13
Harvard	5	18	13	10	11	8	7	8	12
Michigan	2	11	2	13	8	8	13	15	11
Stanford	3	8	2	5	3	3	9	8	11
Cincinnati	1	2	4	4	3	..	8	4	10
Maryland	..	..	..	4	2	3	2	2	10

CHEMISTRY

American University

NORMAN BEKKEDAHL, "Dimensional Changes in the Manufacture of Electrotypes." DAVID JAMES PRICE, "Dust Explosions in Industrial Plants."

Brown University

FREDERIC COWLES SCHMIDT, "A Liquid Ammonia Calorimeter and Some Heats of Solution." CLARENCE STEINER SHERMAN, "Some Phenylgermanium Compounds." JOSEPH EDWARD SMITH, "Studies Relating to Some Reactions of Aliphatic Boranes in Ammonia and Ethylamine." GORDON KIDD TEAL, "A Study of Sodium Germanyl and Potassium Germanyl."

California, University of

JACOB ELSTON AHLBERG, "Heat Capacities and Entropies of Several Inorganic Salts from the Triple Point of Hydrogen to Room Temperature. The Entropies of a Few Aqueous Ions." CLYVE CHARLES ALLEN, "The Development of a Method for the Resolution of Racemic Amines at Low Temperatures." WILLIAM EARLE BRADLEY, "The Reaction of α-Aminomethyl Ethers with Acids and the Rate of Reaction of α-Aminomethyl Sulfonic Acids with Oxidizing Agents." WELDON GRANT BROWN, "Interpretation of the Absorption Spectrum of Bromine." RODERICK CRAIG, "Studies on the Effect of Concentration and of the Degree of Ionization on the Optical Refractivity of Solutions of Certain Amino Acids, Proteins and Other Compounds." CHARLES KASPER, "I. Paramagnetism Independent of the Temperature and the Existence of Electronic Isomers in Polyatomic Ions. II. A New Method for Measuring Diamagnetic Susceptibilities of Substances in Solution Easily and Accurately." EUGENE HAROLD MELVIN, "The Preparation of Large Single Crystals for Use in Extreme Ultra-Violet Spectroscopy. II. The Design of a Vacuum Spectrograph. III. The Transparency of Some Substances in the Extreme Ultra-violet."

California Institute of Technology

CECIL E. P. JEFFREYS, "Photochemical Reactions in Non-Aqueous Solution." RICHARD POMEROY, "The Diffusion of Gases in Oils." S. FREDERICK RAVITZ, "Photochemical Reactions Involving Tri-iodide Ion. Photochemical Reaction between Hydrogen and Iodine Monochloride." RALPH R. WENNER, "The Quantum Yield in the Photochemical Decomposition of Hydrazine." SHO-CHOW WOO, "The Potentiometric Determination of Iridium. Reduction Potential of Quadrivalent to Trivalent Iridium in Hydrochloric Acid Solution. Absorption Spectra, Structure and Dissociation Energies of the Gaseous Halogen Cyanides."

Catholic University

ARTHUR JOSEPH HARRIMAN, "The Rate of Reduction of Some *m*-Nitro Aromatic Compounds."

Chicago, University of

WILLIAM JOSEPH ARNER, "Atomic Disintegration as Observed in the Wilson Chamber." HAROLD ELDON BOWERS, "Raman Spectra and the Carbon-Halogen Band." FERRIS BERTRAND CRUM, "Studies in Hydrolysis of Nitrogen Chloride and Nitrogen Bromide Derivatives." HENRIETTA NOAH DACOSTA, "Saturated Films and a Comparison of the Film Balance and the Ring Method for Surface Tension." ROY DAHLSTROM, "The Energy of Immersion of Powders." LOUIS BRADLEY HOWARD, "Some Theoretical Aspects of the Stability of the Linkage of Carbon to Carbon and Carbon to Nitrogen." HORACE BALDWIN HUDDLE, "A Study of the Stability of Magnesium-Nitrogen Compounds in Relation to the Structure of Chlorophyll." JOSEPH JOHN JASPER, "A Study of Liquid Lenses." ROMEO RALPH LEGAULT, "I. The Oxidation of Thioglycollic Acid in the Presence of Traces of Heavy Metals. II. The Inhibition of the Catalytic Action of Heavy Metals." LEO TOLSTOY SAMUELS, "A Study of the Heat-Labile and Heat-Stable Fractions of Vitamin B in Raw and Evaporated Milks." AGNES ETHEL SHARP, "A Study of the 1,2-Dihalophenylethanes." KEITH TRUEX SWARTZ, "The Action of Sodium Ethylate on Phenylacetonitrile and α-Phenylbutyronitrile." WALTER OWEN WALKER, "A Study of the Reactions of Platinous Chloride Dicarbonyl." RUTH MAUDE WATTS, "Studies in the Introduction of the Arsonic Group *ortho* to the Amino Group in Benzene Derivatives." PETER SUHSUN YANG, "The Biuret Reaction of Amino-Acid Amides."

Cincinnati, University of

RICHARD JAMES BUTZ, "The Oxidizing Action of Fused Anhydrous Caustic Alkalies upon Carbon Compounds." DONALD HOOVER CAMERON, "Studies on the Mechanism of Vegetable Tanning" LEWIS EDWARD GILSON, "Some Improved Methods for the Separation of Amino Acids from Proteins." EDGAR SMITH HILL, "Spontaneous Oxidation of Dialuric Acid." HOOPER LINFORD, "The Reducing Action of Sodium upon Benzyl Chloride in Liquid Ammonia Solution." EDWARD KENNETH MOORE, "The Action of Lime Suspensions on Steer Hide Hair." EARL MAURICE OTTO, "The Oxidation of Carbon Compounds by Fused Alkali Hydroxides." ELMER CURRY PAYNE, "Transference Numbers of Cobalt in Cobalt Sulfate Solutions." JACOB WAIDE PRICE, "Observations on the Mechanism of the Cannizzaro and Klinger Reactions." ELIZABETH SHELOW, "The Near Infra-red Spectra of Ergosterol and Irradiated Ergosterol."

Colorado, University of

JESSE EARL SELLERS, "The Optical-Crystallographic Identification of Strychnine."

Columbia University

IRENE LILLIAN ALLEMAN, "Quantitative Comparative Studies of the Solubilities of Vitamins B and B and G in Acidified Alcohol with Suggestions Regarding the Methods of Determining These Vitamins." JEFFREY HOBART BARTLETT, "Investigation in the Peri-Naphthothiazine Group." BERTHA BISBEY, "Further Experiments upon Vitamins $B(B_1)$ and $G(B_2)$." JESSIE BRUCE BRODIE, "Quantitative Experiments on the Occurrence of Vitamins $B(B_1)$ in the Body." IRVING ARCHIBALD COWPERTHWAITE, "Heats of Transfer and Partial Molal Heat Capacities of Zinc Sulfate in Aqueous Solution from the Temperature Coefficients of Galvanic Cells: An Application of Extended Theory of Debye and Hückel." NICHOLAS DIETZ, JR., "A Potentiometric Study of Acid-Base Titration Systems in the Very Strongly Acid Solvent, Formic Acid." MARGARET M. PARKS, "A Gravimetric Method for the Quantitative Determination of Vanadium." GARFIELD POWELL, "Some Substituted β-Phenylacroleins and Their Reduction Products." CHESTER LOUIS READ, "Rapid Reactions. The Velocity and Heat Effects Involved in the Neutralization of Sodium Dichromate." GEORGE FRANCIS RUGAR, "Some Studies on the Relation of the Stability of Bredig Gold Sols to Cations." CORNELIA TYLER SNELL, "A Study of the Permeability of Graded Nitrocellulose Membranes to Malt Amylase." BASIL CONSTANTINE SOYENKOFF, "The Benzene Dispensions of Basic Soaps in Nickel and Iron." AN PANG TAI, "A Study of Aluminum Oxyiodide Hydrosols." LESLIE JAY TODD, "On the Nature of Aluminum Oxybromide Hydrosols." FRANCES BOWLBY WHALEN, "The Nutritional Significance of Vitamin G."

Cornell University

JOHN WRIGHT ACKERMAN, "The Fading of Dyes and Lakes." GEORGE BANCROFT, "The Equilibrium between Glycogen and Lactic Acid." CARLTON HAWKINS BASCOM, "Some Studies in the Effect of Hydrogen-Ion Concentration on the Detergent Action of Soap." BURTON CHANDLER BELDEN, "Gelatin with Ammonia and Hydrogen Chloride." ALFRED LAURENCE DRESSER, "Equilibrium in the Binary Systems Barium Trinitride, Ammonia Calcium Trinitride, Ammonia." ALTON GABRIEL, "Geochemical Data of Germanium." AVERY BREWSTER GEORGE, "Catalytic Equilibrium between Acetaldehyde and Alcohol." DAVID BIRNEY HAND, "Dimeric Distribution." PAUL ARTHUR RIEDEL, "Filtration Characteristics of Slurries of Calcium Carbonate." EUGENE RAY RUSHTON, "Pyrolysis of Metallic Arsenites." ANTHONY MAX SCHWARTZ, "The Synthesis of Disubstituted Acetylenes." CHESTER BENTON STILSON, "New Occurrences of Gallium." RALPH COLTON TALLMAN, "The Synthesis of Branched-Chain

Fatty Acids." STEPHEN FRANCIS WHEARTY, "The Action of Fluorine on Certain Aromatic Compounds and a Theory of Ring Substitution."

Duke University

KELLY LEE ELMORE, "Temperature Hysteresis in Weston Standard Cells."

Fordham University

LEONARD J. FLIEDNER, "Further Contributions to the Nitration of Disubstituted Benzene Derivatives with Metallic Nitrates." EUGENE HENRY MCCAULIFF, JR., "New Investigations in the Field of Vat Dye Intermediates."

George Washington University

WALTER C. HESS, "Determination of Glutathione."

Harvard University

RICHARD BALTZLY, "Steric Hindrance of Mesityl Compounds." PAUL DOUGHTY BARTLETT, "A Quantitative Study of Certain Reactions of the Carbonyl Group." WILLIAM FAUSSET BRUCE, "I. The Stereoisomeric Oximes of *o*-Hydroxybenzophenone. II. A Study of a Pseudo-Base from 3-Phenyl-4,5-benzisoxazole." CHARLES HERBERT GREENE, "I. The Atomic Weight of Nitrogen. II. The Solubility of Calcium Oxalate in Solutions of Calcium Chloride, Ammonium Chloride and Ammonium Oxalate." ALFRED GEORGE JACQUES, "The Hydrolysis of Ferric Salt Solutions." EDWIN MARCUS NYGAARD, "The Action of Organic Magnesium Derivatives on Highly Phenylated Ketones." HENRY WILLIAM SCHERP, "The Rate of Autoxidation of Some Di-aryl Difluoryls." STEWART HARRISON WEBSTER, "I. The Transformations of Certain Cobalt and Rhodium Ammines. II. The Manganese Dioxide Electrode." TYRRELL HAWLEY WERNER, "I. A Study of Weak Bases in Glacial Acetic Acid Solutions. II. Studies in the Chlorophyll Series." JOSEPH DIXON WHITE, "The Compressibilities and Internal Pressures of Thallium and Indium."

Illinois, University of

ROBERT WILLIAM BALL, "The Separation of Ytterbium by Electrolytic Reduction; Observations on the Rare Earths." HORACE HOPKINS BLISS, "Further Applications in the Use of Bromate in Volumetric Analysis." LOUIS HAMILTON BOCK, "Stereochemistry of Certain Diphenyl Derivatives and of Compounds Consisting of a Benzene Ring and a Nitrogen-Containing Nucleus or of Two Nitrogen-Containing Nuclei." CLAIR S. BORUFF, "An Anaerobic Fermentation of Cellulose and Cellulosic Materials." EUGENE BROWNING, "I. Stereochemistry of Diphenylbenzenes, the Preparation of Stereoisomeric 3,6-Di-(2,4-dimethylphenyl)-2,5-dibromohydroquinones and Their Derivatives. II. The Preparation and Bacteriological Action toward *B. leprae* of Certain Olefinic Acids." DONALD WALKER DAVIS, "The Influence of Molecular Weight on the Dissociation of Hexa-acetylenic Ethanes." ORVILLE EUGENE GOSHLER, "The Preparation and Physical Constants of Perchloric Acid and Some of Its Alkaline Earth Salts." JOHN BEN GOODMAN, "Solubility Relations at High Pressures and Temperatures." GORDON HUGHES, "Observations on the Rare Earths; Studies on Anhydrous Yttrium Salts; Studies on an Electrolytic Separation of the Rare Earths." EARL HANFORD JOHNSON, "Some Derivatives of α-Naphthoyl-*o*-benzoic Acid; and a Study of the Synthesis of Perylene." TSI YU KAO, "A New Method of Ring Closure in the Cyclobutane Series." SIDNEY LIONEL NEAVE, "Chemical Studies on Sludge Digestion." HARRIS EUGENE PHIPPS, "Observations on Polymorphism." ORIN WAINWRIGHT REES, "Structural Relationships Associated with the Hydration of Certain Alkaline Earth Metal Per-

chlorates." LESLIE JAMES ROLL, "A Study of the Enolization of Certain β-Diketones and β-Keto Esters." PIERCE WILSON SELWOOD, "Observations on the Rare Earths; Absorption and Refraction of Certain Rare Earth Salts." ARTHUR CURTIS SHEAD, "Original and Modified Procedures as Applied to the Separation and Determination of the Alkali Metals." WAYNE ANDREW SISSON, "X-Ray Studies of Rolling and Heat Treatment of Sheet Metals." HOWARD AGNEW SMITH, "I. Spectroscopic Studies of the Radiation Phenomena Occurring in Internal Combustion Engines. II. An X-Ray Diffraction Study of Fractionated Paraffin Waxes. III. An X-Ray Examination and Spectrographic Analysis of a Peculiar Intermediate Manganese Steel." JOSEPH GAIL STAMPFLI, "The Preparation and Rearrangement of Tetraphenyl-ditertiary-butyl-ethinylethane." JULIUS WHITE, "I. Catalytic Reduction of Ketones. II. Stereoisomerism in the Diphenyl Series (Synthesis and Resolution of 2,2′,4,4′,6,6′-Hexachloro-3,3′-dinitro-5,5′-dicarboxydiphenyl)." WALLACE WINDUS, "The Synthesis and Resolution of Methionine." JOHN CHARLES ZIMMER, "A Critical Experimental and Theoretical Study by X-Ray Diffraction Methods of Particle Size and Structure in the Submicroscopic and Microscopic Regions."

Indiana University

HARVEY ARTHUR DOYAL, "The Catalytic Activity of Reduced Copper Chromate and of Vanadium Oxide in the Reduction of Nitro Compounds." ROBERT JAMES HARTMAN, "Catalytic Activity of Cadmium." EUGENE WILLIAM KANNING, "Catalytic Decomposition of Kerosene."

Iowa, University of

WILLIS WALDO FLOYD, "The Influence of Strong Electrolytes upon the Catalytic Inversion of Sucrose by Hydrochloric Acid at 30°." OLIVER GROSZ, "Alkyl and Aryl Sulfonyl Derivatives of *o*-Aminophenols." HAROLD CARPENTER HODGE, "The Heat Capacities of Certain Binary Mixtures at 25°." JOY C. LICHTY, "Chlorine Substitution Products of Vanillin and Some of Their Derivatives." G. MERVIN MCNULTY, "I. Microscopic Examination of Precipitates as an Aid to Precise Analysis. Estimation of Sulfates as Barium Sulfates. II. Solubility of Inorganic Precipitates in Inorganic Solvents and Its Relation to Modern Theories of Solution. Silver Chloride." EDWARD WILLIAM NEUMAN, "The Effects of Substituents in the Formation of Thiocarbanilides." FRED W. OBERST, "The Effect of Substituents on the Formation of Stereoisomeric Aldoximes." GUSTAV ESMER OSTRON, "The Decomposition of Thiosulfuric Acid." ROBERT GUTHRIE OWEN, "The Vapor Pressures of Aqueous Solutions of the Chlorides of Certain Alkaline Earth Metals at 25°." FLOYD WALTER PERISHO, "The Absorption of Certain Vapors by Activated Charcoal." PAUL ERWIN PETERS, "The Relative Concentration of the Negative Ions in Different Parts of the Electro-osmose Apparatus." IRA HOTCHKISS PIERCE, "A Method for the Quantitative Estimation of Morphine in Animal Tissues and Excretions." WALTON BARR TANNER, "The Specific Heats of Benzoic Acid and Naphthalene at Low Temperatures." CHARLES BYRON YAGER, "Bromoamine and Grignard Reagents."

Iowa State College

ROBERT E. BROWN, "I. Furfural and Some of Its Derivatives. II. The Relative Reactivities of Organometallic Compounds of Group II Elements." LYMAN C. CRAIG, "Insecticidal Action in the Nitrogen Heterocyclics." JOSEPH B. DICKEY, "Furfural and Some of Its Derivatives." JACK WALDO EICHINGER, "Problems Related to the Commercial Production of Levulose." HARLAN PRESTON GUEST, "Reactions of Inorganic Compounds with Liquid Hydrogen Sulfide." JAMES ROGER HALL, "Chemical Sterilization with Alkalies." LLOYD L. HECK, "I. The Synthesis of Amino Compounds. II.

The Effect of Ultra-violet Light upon Some Organic Compounds." IRAL BROWN JOHNS, JR., "The Electron-Sharing Ability of Organic Radicals: Organo-Mercurials." JAMES HARVEY MCGLUMPHY, "Problems Related to the Commercial Production of Levulose." FRANK EDWARD WARE, "The Electron-Sharing Ability of Organic Radicals: *o*-Chlorobenzyl Radical."

Johns Hopkins University

FRANCES CAMPBELL BROWN, "Diffusion of Dyes in Ethyleneglycol Gels." HAROLD THEODORE BYCK, "The Decomposition of Organic Molecules in the Molecular Beam." WARREN MURDOCK COX, JR., "I. Chemical Composition of Oil of *Ruvettus pretiosus*, the Castor Oil Fish. II. The Synthesis of Certain Isomeric Hexadecanols." WALLACE EDWIN DUNCAN, "A Study of Lead Polysulfides." LOWELL BERRY KILGORE, "Preparation and Reactions of the Lower Alkyl-Oxides." THOMAS SWINDALL LOGAN, "The Dissociation Pressures of Hydrated Cupric Sulfate at 35°C." GEORGE REEL SEIDEL, "Static Adsorption from Solution on Plane Surfaces." MANER LAWTON WADE, "Catalytic Oxidation of Organic Compounds." CHARLES EMORY WATERS, "The Thermal Decompositions of Some Organic Compounds." SAMUEL MYER WEISBERG, "Factors Determining the Curd Character of Soft Curd Milk." RALPH KNIERIEN WITT, "Specific Heats at Low Temperatures."

Maryland, University of

HERMAN H. KAVELER, "A Study of Promoter Action. The Oxidation of Aniline Sulfate by Hot Sulfuric Acid in the Presence of Copper and Mercury Sulfates." WILLIAM C. SUPPLEE, "An Investigation of the Chemical Changes Occurring during the Aging of Cured Hams." BENTON B. WESTFALL, "Determination of the Standard Electrode Potential of Cobalt."

Massachusetts Institute of Technology

BENJAMIN FRANKLIN CLARK, JR., "The Action of Hypochlorous Acid on Toluene, and the Action of Tertiary Butyl Hypochlorite on Certain Classes of Organic Compounds." PAUL HAMILTON DOLEMAN, "A Study in Rates of Esterification." FRED EBERSOLE, "Studies in the Urea Series. The Distribution of Cyanic Acid between Amines." VALENTINE FABIAN HARRINGTON, "Studies in the Oxidation of *m*-Diphenols." EVERETT VERNON LEWIS, "Studies with the Continuous Flow Calorimeter." CHIA WEI OU, "The Pyridine Complexes of Metal Cyanates and the Metal Derivatives of Aliphatic Nitramines." WILLIAM HENRY STRAIN, "The Reactivity of the Hydroxyl-Hydrogen of Certain Aromatic Acids." GEORGE THOMSON, "Initial and Other Significant Temperatures in the Pyrolysis of Pentanes and Pentenes." LU-CHIANG WU, "The Generic Characterization of Ketones in Order I."

Michigan, University of

ROBERT DUDLEY FOWLER, "The Thermal Decomposition of Mixtures of Some Anhydrous Metallic Sulfates." RICHARD MANN HITCHENS, "Boundary Potential Studies on Systems Formed from Weak Bases and Hydrochloric Acid." ERWIN FREDERICK LINHORST, "The Thermal Decomposition of Nitrogen Pentoxide at Low Pressures and the Theory of Unimolecular Reactions." GUILFORD LEROY MACK, "An Investigation of the Relations at the Water Interface of Organic Liquids and Their Binary Solutions." FRANK HANS MOSER, "The Pinacol-Pinacolin Rearrangement. The Comparative Migratory Tendencies of Aryl Groups." JOSEPH DENNIS RYAN, "I. The Polymerization of Asymmetrical Diaryl and Arylalkylethylenes. II. Studies in the Quinoidation of Arylalkylchloromethanes." JOSEPH JOHN THOMPSON, "The Determination of Lead, Manganese and Mercury by Means of Periodate." OLIVER JACOB WEINKAUFF.

"Synthetic Laxatives." CHARLES EUGENE WHITNEY, "An Improved Displacement Pressure Method for the Determination of the Adhesion Tension of a Solid against a Liquid."

Michigan State College

CHARLES HENRY SPURWAY, "The Density of Adsorbed Water on Silica Gel."

Minnesota, University of

GORDON DEAN BYRKIT, "A Critical Study of Certain Reported Abnormal Ammonium Salts." ALBERT LAURENCE CHANEY, "The Electrolysis of Perchlorates in Non-aqueous Solutions." HERTHA RUMACH FRECHE, "The Chemical Action of Ammonium Hydroxide upon Mercurous Chloride." IVAN DUNLAVY JONES, "Studies on Bound Water." KENNETH ALBERT KOBE, "Carbon Suboxide and Its Catalytic Hydrogenation." ANTONIO IGNACIO DE LEON, "A Study of the Properties of the Hydrazinates of the Metals." ELMORE HATHAWAY NORTHEY, "The Absorption Spectra of a Series of Organic Molecular Compounds." EARL FRANCIS OGG, "A Study of the Hydrogen Bromine Reaction under the Influence of Alpha Particles from Radon." ELMER ALEXANDER PEARSON, "I. The Promoting Effect of Copper Sulfide on the Speed of Precipitation of Zinc Sulfide. II. Analytical Studies of Potassium Ferrocyanide." ALLEN DINWOODY ROBINSON, "The Effect of Salts on the Paracasein-Sodium Hydroxide Equilibrium." EDWARD CUSHMAN TRUESDALE, "Chemical Effects Produced by Radon on the System: Hydrogen–Sulfur–Hydrogen Sulfide."

Nebraska, University of

EDWARD FRANKLIND DEGERING, "Catalytic Oxidation of *d*-Glucose and Related Sugars by Iron Pyrophosphates." ROBERT EUGENE ETZELMILLER, "The Influence of the Arsono-Group on the Activity of Nuclear Halogen." EDWIN A. FLUEVOG, "Solubility Relations of Sugars and Related Derivations." CHARLES RICHARD SAUNDERS, "Isomeric Nitro- and Aminonaphthyl Arsonic Acids."

New York University

HAROLD EDWARD ACHILLES, "The Thermal Decomposition of Propylamine." WILLIAM BENNO BROWN, "Preparation of Some Derivatives of Formocholine and Choline." MORRIS BORIS JACOBS, "Kinetics of the Persulfate-Iodine Reaction in Highly Dilute Aqueous Solution." ERNEST MACCRACKAN LIVINGSTON, "The Oxidation of Hydrogen Sulfide." SAMUEL NATELSON, "Condensation of Unsaturated Hydrocarbons with Phenols—Mechanism of the Condensation of the Ethylenic Bond with Phenols." E. WENDELL RIBLETT, "The Oxidation of Ethane." JOHN ETTORE RICCI, "Some Three-Component Salt Solutions Involving Iodates." MORRIS SCHWARTZ, "The Decomposition of Diethyl Ether in Contact with Platinum and Tungsten." RICHARD AUGUST SMITH, "The Preparation of Phenyl-Substituted Cholines and Allied Derivatives." OTTO F. STEINBACH, "The Kinetics of the Reaction between Persulfate and Thiosulfate Ions in the Presence of Catalysts." WORTH WADE, "The Wave-Length Dependence of the Hydrogen Chlorine Reaction."

North Carolina, University of

GRADY GEORGE ALBRITTON, "A Comparison of the Behavior of Tartrate and Oxalate Solutions of Columbium and Tantalum Oxides." RALPH MILLEDGE BYRD, "A Study of the Soda-Alum System and Volumetric Method for Determining Sodium." DAVID RAMSEY ERGLE, "The Bromination of 1,5-Dihydroxynaphthalene." JOHN BRYANT GALLENT, "The Composition of Satin White." AUSKER EDWARD HUGHES, "The Action of Sulfur Dioxide on the Phosphates of Calcium." HARVEY ALBERT

LJUNG, "A System of Qualitative Analysis for the Anions." JEPTHA P. SANDERS, "Lithium Sulfate—Aluminum Sulfate—Water and the Quantitative Determination of Sulfate, Aluminum and Lithium."

Northwestern University

HOWARD COURTNEY BENEDICT, "A Correlation of the Physico-chemical and Physiological Properties of the Solutions of Some Alkaloid and Alkaloid-Like Salts." HARRY THOMAS BOLLMAN, "The Function of the Allyl Group in the Pyrolysis of Unsaturated Hydrocarbons." CHARLES EZRA GROSS, "I. The Action of Dilute Alkali on Trimethylxylose. II. The Utilizability of Certain Substituted Carbohydrates by Bacteria." LLOYD LEROY ISENHOUR, "Dehydration Reactions of Xylose." EVAN WILLIAM MCCHESNEY, "The Chemistry of Proteins in Liquid Ammonia. I." HARRY TRAINOR NEHER, "The Action of Dilute Alkali on Trimethyl *l*-Arabinose." CHARLES LAMAR THOMAS, "α,β-Unsaturated Acids and Their Synthesis with Ketene."

Notre Dame University

SISTER M. FLORENTINE DALY, "A New Modification of the Reformatsky Reaction."

Ohio State University

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HENRY LEROY COLES, "Zirconium Alloys."

Pittsburgh, University of

GEORGE RAYMOND FITTERER, "The Presence of Nonmetallic Impurities in Steel, Resulting from the Deoxidation of That Steel with Manganese and Manganese-Silicon Alloys."

Wisconsin, University of

ROLAND ANDREW RAGATZ, "The Action of Inorganic Energizers in Casehardening Compounds."

Yale University

ETIENNE JEAN PAUL SPIRO, "Evolution of the Iron-Oxygen Constitutional Diagram."

MINERALOGY

Ohio State University

HELEN MAE BLAIR, "Equilibrium Studies in the Lithium–Alumina–Silica System."

Arsenic Poisoning Widespread, Beauty Parlor Clippings Show. Hair clippings collected from beauty parlors and barber shops and subjected to chemical analysis show that very many of us are carrying around mild cases of arsenic poisoning without ever suspecting it. It may become serious enough to cause "patch baldness," or bleachings or discolorations of the skin. This evidence that a considerable proportion of our population are "arsenic carriers" was presented by Drs. C. N. Myers and Binford Thorne, of the New York Skin and Cancer Hospital, before the American Chemical Society. The arsenic comes from the widespread use of poison sprays to protect fruit and other crops, and even from clothing made from cotton sprayed to keep off boll weevil.—*Science Service*

Teetotalers Nevertheless Have Ethyl Alcohol in Them. The question whether the brain, liver, blood, etc., of humans and animals that have never taken a drink of an alcoholic beverage, contain ethyl alcohol has interested biochemists in the past. By specially developed micro methods, Prof. Alexander O. Gettler, toxicologist of Bellevue Medical College of New York, Joseph B. Niederl, and A. A. Benedetti-Pichler have actually isolated 100 per cent pure ethyl alcohol from the normal brain, liver, and blood. The isolated alcohol was shown at the meeting of the American Chemical Society where the experiment was described by Prof. Gettler.—*Science Service*

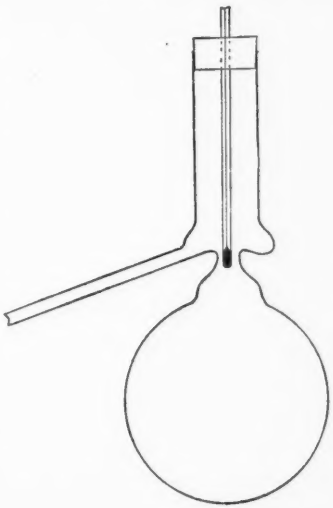
Sweet Milk Corrodes Nickel. Sweet milk corrodes nickel, often used on milk cans and other utensils. H. A. Trebler, of Ithaca, N. Y., and W. A. Wesley and F. L. Laque described the effects of operating conditions on corrosion of various parts of pasteurizing equipment before the meeting of the American Chemical Society. Both plant and laboratory tests were made. When milk is being heated, a film of protein protects the nickel, but when milk is cooling corrosion is rapid. This depends on the amount of aeration, temperature, and other factors.—*Science Service*

Dates Have High Mineral Content. Dates were recommended as a dietary supplement, before the recent meeting of the American Chemical Society, by M. M. Cleveland and Professor C. R. Fellers of the Massachusetts Agricultural College. Analysis of imported dates from Iraq showed unusually high mineral content. The fruit is especially strong in potash, a necessary mineral food element.—*Science Service*

A DISTILLING FLASK WHICH PREVENTS REFLUXING IN THE VACUUM DISTILLATION OF HIGH-BOILING LIQUIDS

PAUL E. BURCHFIELD, UNIVERSITY OF CINCINNATI, CINCINNATI, OHIO

In the distillation of high-boiling liquids under reduced pressure, there is a marked tendency for the liquid to condense on the relatively cool neck of the distilling flask and reflux into the main portion of the distilling liquid. While this tendency greatly reduces the speed at which distillation takes place, it is especially objectionable when there is danger of the contents of the flask decomposing upon prolonged refluxing.



Still heads have been described which would overcome these difficulties (*1*). Most of them, however, are quite complicated and would require the services of a professional glass blower for their construction. A distilling flask which very satisfactorily prevents refluxing, and which is easily constructed after a little experience in glass blowing, is shown in the diagram. The flask was constructed upon the suggestion of Dr. F. E. Ray, Director of Research.

The neck of an ordinary round-bottomed flask is heated, immediately above the bulb, until the diameter is 7–10 millimeters. Above this constriction the neck is heated and distended. The annulus is formed by forcing the constricted area into the hot, distended portion of the neck. Sealing a side arm at the lower side of the annulus completes the flask. This type of flask was used in the distillation of a number of high-boiling, organic liquids. In all cases it successfully withstood the highest vacuum obtained using an ordinary hyvac oil pump.

(*1*) K. HICKMAN AND W. WEYERTS, "The Vacuum Fractionation of Phlegmatic Liquids," *J. Am. Chem. Soc.*, **52**, 4718 (1930).

Ergot Injured if Not Kept Cool. Ergot, a highly important drug offered to the prescription trade as a fluid extract, must be kept cool or it will spoil, Drs. Maurice I. Smith and E. F. Stohlman of the National Institute of Health, Washington, told members of the American Chemical Society. They also found that oxidizing substances added to the extract hastened its deterioration, whereas reducing substances, which absorb oxygen instead of adding it, aided in its preservation.—*Science Service*

Correspondence

FRAGMENTS OF EARLY INDUSTRIES IN SOUTH JERSEY

DEAR DR. GORDON:

I am sending to you under this cover the galley proof of my paper which I have looked over and corrected. . . . The day I received the proof of this paper from you I also received from Judge Otis of Tuckerton an original prospectus of the Paper Plant of the Wading River Manufacturing Company. A copy of this document I am enclosing in the belief that it may be of interest to your readers. . . .

Judge Otis acquired a lot of "trash"—old books, papers, deeds, boxes, etc., and in a book as a bookmark was this document.

Very cordially yours,

K. BRADDOCK-ROGERS

UNIVERSITY OF PENNSYLVANIA
PHILADELPHIA, PA.

* * * *

PROSPECTUS OF THE PAPER MAKING PLANT

Sir—

We hand you herewith a copy of the Report of the Wading River Manufacturing Company, and will briefly state the nature of its contents, and our reasons for calling your attention to it.

The Company is located on Wading River, in Burlington County and has the best water power in West Jersey, capable of driving a dozen mills of the first order. It is forty miles from Philadelphia, and being but a short distance above tide water, has the advantage of water communication with New York, at a cost of $2.25 per ton. It was incorporated in 1835, by the State of New Jersey, with a capital of $200,000, and general manufacturing privileges. The object of the proprietors in its formation was to create an establishment for the conversion of the salt grass of the neighborhood into wrapping paper, binders' boards, bonnet boards, etc. That object has been accomplished, and one mill is now at work, manufacturing nearly a ton of paper per day. Its property consists of 5000 acres of land at and near the mills, much of which may be advantageously brought into cultivation. Part of it is meadow, yielding the grass required for the works, and the remainder is covered with wood of various descriptions that is valuable, and that will come gradually into action for the purposes of the Company. In addition thereto, there is a farm of five hundred and fifty acres, much of which is now in cultivation. On the property are: I. A *double* Paper Mill, two hundred and forty feet in length. One of the Mills is now in full operation, and the other wants little more than the millwright work and machinery, which it is proposed to put up without delay. II. A new Stone Grist Mill. III. A Saw Mill and Machine Shop. IV. Blacksmiths' and Carpenters' Shops. V. Stone Store House and Boarding House. VI. Dwellings for the Superintendent and the workmen—furniture, horses, mules, wagons, etc.

The Company own also one half of a schooner that will perform the transportation of goods to and from New York and Philadelphia.

By the Report it will be seen that when the second mill shall be completed there may be made daily 6000 pounds of paper and binders' board, the cost of which is estimated at $73.37. The selling price of the worst paper that is made is 4 cents per pound, and of binders' board $3^1/_2$ cents. Averaging the whole at $3^1/_2$ cents, the daily product would be $210, and the daily cost being as above, leaves a profit of $137, equal to $40,000 per annum.

This product may be doubled by the erection of another mill at a cost of $40,000.

The articles produced are of a kind for which the demand is almost unlimited. A very small reduction of price would close nearly all the mills that now manufacture similar articles, and by degrees nearly the whole of the vast water power of the Company might be applied to the conversion of this now useless material into excellent paper and binders' boards. The abundance and cheapness of its water power—the proximity and cheapness of the raw material—the abundance of fuel possessed by the Company—and the excellence of its works—will enable it to defy competition from any quarter, as in no other part of the Union are those advantages united to an extent approaching that which they possess. If we estimated those advantages as being equal to only one cent per pound, a profit of $60 per day might be realized from the mill now erected, by selling their products at the precise *cost of manufacture* elsewhere; but the owners of other mills must have a *profit* of at least one, or one and a half cents per pound, and we claim the same.

In addition to the income to be derived from the manufacture of paper, the business of the Store has yielded a profit of nearly $3000 per annum, and with the extension of the works it must increase. The Grist Mill, the Farms, and the Schooner will all contribute, and will undoubtedly meet any demands upon the Company that may not now be anticipated.

In addition to the sources of revenue thus opened, there is every reason to believe that as fast as the wood is cleared off it may be replaced by the mulberry, and the cultivation of silk most advantageously introduced, by which the lands of the Company would be rendered as productive as the most fertile soils of New York or Pennsylvania.

The stock of the Company originally created was $65,000; since increased to $95,000, all of which has been paid up. The total expense of the works as they now stand, exclusive of a mortgage of $10,000, is about $110,000, and the completion of the second mill will cost by contract, $10,000. It is proposed to increase the stock to $120,000 and to offer $25,000 thereof to a few gentlemen, of whom you are one. If you feel disposed to take any portion of it, we shall be happy to hear from you.

The expense has exceeded our estimates very considerably, although what has been produced has been cheaply done when compared with many other works. We are induced to offer this portion of the stock for sale from the great desire we feel to have the whole brought promptly into active operation, and from a confidence that the sooner such is the case, the sooner we shall find it expedient to extend the buildings and increase the operations of the Company, by which value will be given to its lands and its extensive water power, now remaining unproductive. We are

disposed to believe that we have laid the foundation of one of the most extensive and profitable concerns in the Union, and that nothing is now required but to build upon it. By reference to the documents in the accompanying reports you will see how far the views now submitted to you are confirmed. Those who may now subscribe will have the benefit of the labor we have given in building up the concern, and we shall benefit by the increase of productive power that will arise out of a more prompt extension of the works than might otherwise take place.

We are yours, respectfully

Henry C. Carey

Philadelphia, August 3, 1837 William M'Carty

CORRECTION: ALEXANDER BORODIN—CHEMIST AND MUSICIAN

Mr. Ferdinand Kopecky has very kindly directed my attention to an error in my recent article entitled, "Alexander Borodin—Chemist and Musician," which appeared in the September issue of THIS JOURNAL.

The editor has graciously afforded me the opportunity to publish the correction pointed out by Mr. Kopecky and accordingly I quote directly from his letter as follows: "I noticed an error which I knew might occur with the confusion of dates in various reference works. In some sources the dates are given to correspond with the Julian calendar while in others to the Gregorian calendar. Dr. Getman, in his biography, has evidently shortened the life of Borodin by exactly the difference between the two calendars. Borodin, I find, was born on October 31, 1834, and died on February 16, 1887 (Julian calendar used during his life), or on November 12, 1834, and February 28, 1887, according to the Gregorian calendar."

Furthermore, Mr. Kopecky points out the omission, from the list of references to Borodin's chemical papers of an article treating of the preparation of acid fluorides which was reported in *Jahresber. Fortschritte Chem. verwandt. Theile Wiss.*, **1862,** 264, and in *Compt. rend.*, **45,** 553.

I am grateful to Mr. Kopecky for these corrections and welcome the opportunity to publish them in the journal in which the biographical sketch appeared.

FREDERICK H. GETMAN

Minerals in Ashes of Honey. Dark honey has three and a half times more mineral matter than light honey. Silicon, iron, copper, and manganese are the minerals in order of amount. This report on honey minerals was made to the American Chemical Society meeting by Dr. H. A. Schuette, professor of chemistry at the University of Wisconsin, and Kathora Remy.—*Science Service*

Abstracts

TEACHING OBJECTIVES, METHODS, AND SUGGESTIONS

Getting the Student to Use His Own Intellect. M. LOUISE NICHOLS. *Science*, **74,** 152–3 (Aug. 7, 1931).—The value of individual laboratory work as now largely conducted is questioned. Too elaborate laboratory directions do not encourage interest, initiative, and resourcefulness in the student. It is not suggested that individual laboratory work be discontinued, but rather is it suggested that this work be changed so as to arouse in the student, in so far as the resources of the school permit, the desirable qualities generally considered as its purpose. G. H. W.

Objective Examinations and Habits of Honesty. J. R. PATRICK. *Sch. & Soc.*, 34, 320–1 (Sept. 5, 1931).—The realization that marks have a significant meaning creates even in the youngest a desire to be on top. In his attempt to rank high, one soon learns to borrow from his neighbor whatever information he may obtain, thus sacrificing certain ideals, establishing habits of dishonesty, and unconsciously stunting his character growth. Many feel that the old type of examination is responsible for existing conditions, and that only the objective type can remedy the situation. If a student knows he must depend on his own resources, there will be created within him self-reliance and an ability to reason and think for himself. K. S. H.

ADMINISTRATIVE PROBLEMS AND DEVICES; CURRICULA

Reorganization of Educational Work at the University of Chicago. REPORT. *Sch. & Soc.*, **32,** 734–6 (Nov. 29, 1930).—Chicago's intention to abandon the old system of a four-year course as a requisite for a degree and entitle a student who feels that he has acquired a general education to try comprehensive examinations, has been announced by Pres. Hutchins.

By such a plan, the capable student will save time, while the average will obtain a better education. Having been graduated as sufficiently satisfactory, such a student will be permitted to go on into one of the upper divisions (graduate or professional school), and upon passing the same type of examinations there, will be granted his degree. Professional degrees will be awarded by the professional schools—but other degrees will be awarded only on the recommendation of the entire division, and not by any one department. K. S. H.

If We Abolish College Credit. H. B. ENGLISH. *Sch. & Soc.*, **33,** 567–9 (April 25, 1931).—If a student is to appreciate the true goal of education and the fact that he must accomplish something worth while, he must be divorced from credit hours. The credit system has created a barrier between the individual and his instructor and has made education largely a mechanical process.

In answer to the question how to determine who shall graduate if the credit system is abolished, Pres. Hutchins of Chicago proposes comprehensive examinations; a similar method having been successfully used for several years at Antioch and other colleges.

The writer suggests another means of determining one's fitness for a degree, *i. e.*, a recommendation made by several members of the faculty who have personally acquainted themselves with the ability, knowledge, etc., of the individual. This would place an enormous burden on the professor, but it would nevertheless increase the personal relationship between instructor and student. The value of such a plan must be obvious. K. S. H.

Committee on the Relation of School and College. W. M. AIKIN. *Sch. & Soc.*, 33, 274–6 (Feb. 21, 1931).—The domination of the careers of those students of secondary schools who aim to go on into colleges and universities has seriously interfered with the progress of these intermediate institutions.

Through the efforts of a Committee on the Relation of School and College, appointed by the Progressive Educ. Assoc., it is hoped that a superior type of secondary education may result, whereby the welfare of the student will be the greatest concern.

The coöperation of the colleges is necessary and various institutions have already indicated their willingness to conduct experimental studies concerning such a relationship.

Finally, a national conference of representatives of colleges and secondary schools will be called and the suggested changes turned over to them, with the hope that the much desired type of secondary education may result. K. S. H.

Professional Talents and Faculty Assignments. See this title, p. 2285.

KEEPING UP WITH CHEMISTRY

Food Poisoning and Poisonous Foods. C. H. LAWALL. *Am. J. Pharm.*, 103, 298–323 (June, 1931).—A Popular Science Talk given at the Phil. Coll. of Pharm. and Sci. This lecture discusses the factors and causes of sudden and severe illness and sometimes death when people sit down to what appears to be an apparently normal meal. Everybody wants to call it ptomaine poisoning. There is no such thing as ptomaine poisoning *as the term is commonly used.* Ptomaines are never produced in the early stages of putrefaction. They represent the late degradation products. The proper term to use to describe such cases of illness according to latest authorities is "food poisoning" or "food infection" or "food intoxication." If a specific term is to be used to denote the cause, the term toxin is generally applicable. According to modern bacteriological science putrefaction does not necessarily develop poisons in food unless the food is also affected with a special organism of one of the types that yield toxins; such as, botulinus bacillus or the paratyphoid bacterium. The paratyphoid type of food poisoning is the one popularly known as ptomaine poisoning. Beef, pork, milk and milk products, eggs, puddings, and salads are especially susceptible to the organisms responsible for the toxic effect. The bacilli are easily killed by heat but the toxins are heat resistant. Chemical poisoning of foods and food sensitiveness are also discussed. G. O.

The Colloid Chemistry of Insanity. WILDER D. BANCROFT AND G. HOLMES RICHTER. *J. Phys. Chem.*, **35**, 1606–23 (June, 1931). S. A. L.

Artificial Insanity. MARJORIE VAN DE WATER. *Sci. News Letter*, **20**, 54 (July 25, 1931).—Some possible clues as to the cause and cure of dementia praecox have resulted from studies on the effect on the human organism of too little oxygen. An apparatus constructed so that the same air is breathed over again was used. As the oxygen content of the air decreases, the more complex mental processes are the first to fail. The field of attention is narrowed, memory and the sense of relationship are impaired, and the inner nature and character are revealed. The "rebreather" may be used to determine an aviator's "ceiling," above which he may not rise and retain his faculties unimpaired.

Patients suffering from dementia praecox have been revived for a short period by subjecting to an atmosphere of carbon dioxide and oxygen. The results of the tests indicate that a certain amount of oxygen is necessary for normal functioning of the mind, and that while these patients breathe the same air as every one, yet they are unable to make the same use of it. It has been found that the brain cells of persons afflicted with dementia praecox contain less iron than normal cells. H. T. B.

Sodium Metasilicate. ANON. *Silicate P's & Q's*, **11** (Aug., 1931).—Sodium metasilicate pentahydrate in quite uniform crystalline form, free from dust, quickly soluble without residue in cold water, and well standardized, has recently been made available to industry. Some of its properties are: m. p. 71.8°C.; sol., 2 lb. per gallon water at atmospheric temperatures; absorbs heat as it dissolves; and yields a solution having a high pH value and good buffer action. Its properties make it desirable for cleansing operations, such as washing fabrics, glassware, metal pieces, etc. H. T. B.

An Electronic Explanation and Hypothesis. J. H. HOCH. *Am. J. Pharm.*, 103, 329–31 (June, 1931).—An explanation of the changes that take place in the methylene blue molecule when, under the influence of a reducing agent, methylene blue is changed to its leuco form. As a matter of fact the quinoid binding with its two double bonds is changed to a benzoid binding. Since the dye character depends upon the quinoid binding it is obvious that in this way the substance must be decolorized. Electronic formulas are used to show this. G. O.

Observations upon the Filterability of Bacteria, Including a Filterable Organism Obtained from Cases of Influenza. PROFESSOR ARTHUR ISAAC KENDALL. *Science*, 74, 129–39 (Aug. 7, 1931).—By the use of a new culture medium and technic, bacteria have been induced to assume alternately filterable and non-filterable forms. The "filterable viruses" responsible for several diseases, notably influenza, have been induced to assume a non-filterable form. Staphylococcus bacteriophage seems to be the filterable state of the corresponding non-filterable bacterium. G. H. W.

Reclamation of Sewage. G. ROSS ROBERTSON. *Ind. Eng. Chem., News Ed.*, 9, 262–4 (Aug. 20, 1931).—In an experimental activated sludge plant combined with heavy chlorination, the city of Los Angeles has demonstrated that the city's dirtiest sewage can be transformed in 12 hours into a clean, sparkling water, comparable in quality to the

supply in the Los Angeles aqueduct itself. The estimated cost is 1.5 cents per 100 cu. ft., which is less than one-half that of bringing Colorado River water to the city.
G. W. S.

Water Main Sterilization at Milwaukee. N. A. THOMAS. *Ind. Eng. Chem., News Ed.*, **9**, 264–5 (Aug. 20, 1931).—Liquid chlorine, either as gas or solution, was found to be most effective in sterilizing new water mains. G. W. S.

Element 85. See **Standing Room Only—If Any,** p. 2286.

SCIENTIFIC REVIEWS AND BIBLIOGRAPHIES

Fifty Years' Experimental Research upon the Influence of Steam on Combustion of Carbonic Oxide. (Third Liversedge Lecture.) WILLIAM ARTHUR BONE. *J. Chem. Soc.*, **1931**, 338–61.—Experimental work and tentative theories advanced are discussed in chronological order. The questions as yet unanswered are summarized.
O. R.

Recent Advances in Science. *Sci. Progr.*, **26**, 16–26 (July, 1931).—*Biochemistry*—P. EGGLETON. (1) The Absorption of Foods from the Alimentary Tract, 2) The Biochemistry of Boron and the "Heavy Metals," (3) Linoleic Acid as an Accessory Food Factor, (4) The Physiology of Amoeboid Movement. *Physical Chemistry*—O. H. WANSBROUGH-JONES. Measurement of Velocity of Reactions. A. E. C.

HISTORICAL AND BIOGRAPHICAL

Albert Abraham Michelson. (*1*) *Les Prix Nobel en 1907.* P. A. Norstedt & Söner, Stockholm, Sweden, **1909**, pp. 10–11, 63–7 (with portrait). (*2*) **Albert A., Michelson,** R. A. MILLIKAN, *Science*, **73**, 549–50 (May 22, 1931). (*3*) **Michelson's Economic Value,** R. A. MILLIKAN, *Science*, **69**, 481–5 (May 10, 1929). (*4*) **The Michelson Meeting of the Optical Society of America.** H. G. BOUTELL, *Sci. Mo.*, **27**, 567–9 (Dec., 1928). The Michelson-Morley Ether-Drift Experiment, *Sci. Mo.*, **27**, 570–1 (Dec., 1928). (*5*) **Prof. A. A. Michelson, For. Mem. R. S.** *Nature*, **127**, 751–3 (May 16, 1931). M. W. G.

Some Medicinal Substances Employed by the South in the War between the States. W. A. PROUT. *Am. J. Pharm.*, **103**, 336–40 (June, 1931).—Interesting data gathered by the late Dr. Jos. Jacobs of Atlanta showing how the South turned its attention to its native herbs and plants. G. O.

THE PHILOSOPHY OF EDUCATION

Professional Talents and Faculty Assignments. L. W. MILLER. *Sch. & Soc.*, **32**, 729–31 (Dec. 29, 1930).—An effort should be made in every university to recognize the varying talents of the faculty members and then place them in the department in which they rightly belong.

A typical research man is necessarily introverted. He is continually working toward an ever-narrowing center, finally to be recognized as an authority in one particular field. The teacher, however, should work away from a center and come to know all human thought. Thus he is enabled to place his own interests in their right relation to other fields and ways of thinking.

The training of undergraduates has been characterized by many university leaders as being unimportant—the stress being placed on graduate students. The writer points out the fallacy of such emphasis for, after all, most of our leaders of all phases of life, except technical and scientific, come from the ranks of the undergraduate body.

Nevertheless, the need for both types of faculty members is obvious. A single individual cannot be both a research worker and a teacher. Give to the undergraduate body the teacher who reads books of broad general interest and thus can stimulate his students to do likewise, for through such reading they acquire perspective and a sense of relative values. K. S. H.

Useless A B C's. DONALD ROSE. *Forum*, **85**, 374–8 (June, 1931).—R. advocates less routine in elementary education and more common sense. He believes it possible that better teachers would be found in our schools if the system were less rigid. Much of the effort on arithmetic, geography, etc., as taught at present, is wasted.
S. A. L.

CONTEMPORARY NEWS AND COMMENTS IN SCIENCE AND EDUCATION

The Chemical Road to Progress. WILLIAM J. HALE. *Chem. Markets*, **29**, 21–6 (July, 1931).—"Those industrialists and politicians who cry aloud for higher prices on

agricultural staples, in order that the money paid to the farmers will find outlet in greater purchasing power for industrial products, are only crying for their own destruction...

"Chemistry decrees that organic chemical mixtures—agricultural staples if you wish—never again can sell for more than the sum of the chemical values of their several components...

"Wherever a high cost of production prevails, the agriculturist, as well as the industrialist, must cease this particular pursuit. It is the constant lowering in production costs that makes for success. What we want are low-priced basic commodities, and these we will have..." O. R.

The New Admission Requirements of the University of California. R. WALTERS. *Sch. & Soc.*, **32,** 732–4 (Nov. 29, 1930).—In August, 1931, a new plan goes into effect at the Univ. of Cal., whereby any recommended graduate of an accredited high school in Cal. will be admitted to the University without further examination. This procedure was adopted by the university upon the suggestion of the Cal. H. S. Principals' Assoc.

The university will set up a nucleus of subjects to be completed by the H. S. student and will send to each accredited secondary school reports of the records of freshmen received from that school. K. S. H.

Standing Room Only—If Any. EDIT. *Am. J. Pharm.*, **103,** 295–7 (June, 1931).—This is a clever editorial upon the newly discovered element, number 85. The discovery was made by Dr. Allison, Edgar Murphy, Prof. Edna Bishop, and Anna Sommer, all of the Alabama Polytechnic Institute. Dr. Allison and Mr. Murphy are the same scientists who a year ago discovered number 87. Number 85 is not yet separated for only one part in a billion is present in the substance examined. An attempt is being made to extract a more concentrated form of the element from monazite sand and good progress has been made. G. O.

The American Association for the Advancement of Science; Reports of the First Pasadena Meeting of the American Association for the Advancement of Science and Associated Societies. *Science*, **74,** 103–23 (July 31, 1931). G. H. W.

The Indispensable Uses of Narcotics. Narcotics in "Patent Medicines." ARTHUR J. CRAMP. *J. Am. Med. Assoc.*, **96,** 1950–2 (June 6, 1931).—It appears that the use of opium or its derivatives in exempt preparations has increased within recent years. "It seems probable that governmental agencies are doing all that can humanly be done under present appropriations and limited personnel to obtain data that will enable a check to be kept on the manufacture and sale of 'patent medicines' containing narcotics. It also seems probable, however, that Congress should make it possible for those agencies so to increase their activities that detailed records could be kept of every ounce of narcotic drugs that is purchased for the manufacture of 'patent medicines' from the time they go into the hands of the nostrum maker until they reach the ultimate consumer." S. A. L.

The New Educational Plan at the University of Chicago. WM. S. GRAY. *Sch. & Soc.*, **33,** 513–9 (April 18, 1931).—Since the adoption of its new educational plan, the U. of Chicago consists of: the college, four upper divisions, and six professional schools. The conditions and motives which led to this reorganization are discussed. In the fall of 1930, the junior and senior colleges and the graduate schools were replaced by 5 divisions: the humanities, the social sciences, the physical sciences, the biological sciences, and the college. The completion of the college requirements is to be ascertained by comprehensive exams., along with any available information regarding a student's ability and attainments. The upper divisions will offer stimulating opportunities for advanced and specialized study and will aim to promote research. K. S. H.

The Louise C. Buhl Hall of Science of the Pennsylvania College for Women. See page 2287.

Research Reports from the Meeting of the A. C. S., Buffalo, August 31–September 4, 1931. See page 2291.

Electrons Speed within Dense Solids. See page 2296.

Synthetic Antiseptic Is New Hookworm and Ascaris Remedy. See page 2297.

Common Water Purifier Prevents "Athletic Foot." See page 2298.

Research on Paperboard Containers at Mellon Institute. See page 2299.

Brasseur, Young Belgian Scientist, to Work with Langmuir Prizewinner. See page 2299.

Grasselli Medal to L. V. Redman. See page 2299.

Professor Desch to Lecture at Cornell under Baker Foundation. See page 2299.

Pittsburgh Section, A. S. S. T. Sponsors Metallurgy Course. See page 2300.

Metallurgical Advisory Board Holds Annual Meeting at Carnegie Institute of Technology. See page 2301.

Contemporary News in Chemistry and Education

THE LOUISE C. BUHL HALL OF SCIENCE OF THE PENNSYLVANIA COLLEGE FOR WOMEN

DOROTHY EDSALL,* PENNSYLVANIA COLLEGE FOR WOMEN, PITTSBURGH, PENNSYLVANIA

Working with insufficient equipment in inadequate quarters does not make the pursuit of science an attractive one to undergraduate students. At least, that was what we found at Pennsylvania College for Women last year, where the science department had long been most inconveniently housed. So it was with the most eager interest that we heard the announcement of a gift to the college of $100,000 from the BUHL FOUNDATION of Pittsburgh and the plans for the erection of a new science hall to bear the name of LOUISE C. BUHL, wife of the originator of the foundation. From the day of breaking ground on June 7, 1930, we watched closely every move that would bring nearer to completion the building that was to be the Louise C. Buhl Hall of Science. Finally, on December 29, 1930 it was completed, and we were allowed to make our first inspection of its interior, fully equipped.

With its exterior we were already familiar. We knew well and liked its Georgian colonial design, in which both the style of architecture and the red brick and Indiana limestone materials helped to achieve a combination of the graciousness befitting a college atmosphere and the more severe dignity which we like to associate with science. Because of the hilly contour of our campus, the three-story building has but two stories above the ground on the campus side, and the ground floor is forced to content itself with one side in darkness. Before we had entered the building, statistics-lovers had informed us that our new science hall measured 109 × 63 feet, and was a blunt H in construction with wings on the east and west sides.

Duly primed with this information, we entered the blue-green doors, and, shutting our eyes to the allurements of the first floor, we proceeded to tour the ground floor. The first door on our left was that of the library and seminar room, measuring 32 × 23 feet, with a deep fireplace, attractive seminar tables and comfortable Windsor chairs, luxurious Oriental rugs, and cozy reading-lamps lighting the book-encircled walls. In the main cloakroom and restroom we eyed appreciatively the rows of hangers and the hundred pigeonhole lockers for the safe bestowal of smocks and books.

Next door is the pump room, which contains a Frigidaire system for cooling the water in the drinking fountains throughout the building, a vacuum pump, a hot-water circulating pump, a D. C. generator, 24 storage batteries, and the main-line electrical switches. Adjoining the pump room we found the stockroom, which is prepared to house all the biological, physical, and chemical apparatus used in the building. We noticed with interest that all the cupboards in the room are of steel, and that all the smaller pieces of apparatus are kept in steel boxes, hinged at the middle, to obviate the necessity of removing the entire box each time a piece of apparatus is needed. Next to the stock room is an unpacking room, and at the end of the corridor is an underground vault for the storage of chemicals. It is connected with the building by an eight-foot areaway, closed at both ends by fireproof doors, which thus afford complete protection to the rest of the building.

Turning to the right side of the floor, we found the temporary home of the psychology department. It is represented by a lecture room, an experimental laboratory,

* Sophomore major in chemistry, Pennsylvania College for Women, 1930–31.

an office for the instructor, and a specially constructed sound-proof room for use in experiments.

At last we passed to the first floor via the automatic elevator, and found ourselves at the entrance of the main lecture and demonstration room of the building, a room, which, with memories of our previous antiquated lecture rooms, we hailed with rejoicing. Here ninety-eight students may be accommodated in unusually comfortable seats with movable arms. Part of the equipment is a fire-proof moving-picture booth, and the windows are fitted with Draper double shades, moving in slots, to secure more efficient darkening of the room and to prevent the all-too-common noise of flapping shades when the windows are open. The demonstration table, thirteen feet long, is completely fitted with electricity, gas, air, vacuum, hot and cold water, steam, an individual hood, a sink, and a pneumatic trough which may be covered at will. We were particularly impressed with the blackboards, which are here and everywhere else throughout the building lighted by reflector lamps and shaded by artistic metal aprons, to prevent glare on the student's eyes. From the lecture room we passed to the preparation room directly behind, and to the museum, which is lined on three sides with vertical glass-doored cases, and has in the center four horizontal glass cases for the display of specimens.

The rest of the first floor is occupied by the department of biology with two classrooms, four laboratories, and two instructor's offices. We were interested to find that in all departments the instructor's office is connected with a private laboratory, and is immediately accessible to classrooms and student laboratories, an arrangement of advantage both to students and instructors.

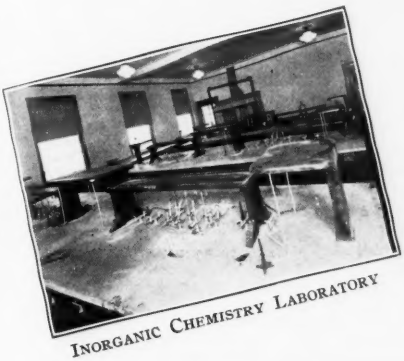
The office of the botany instructor faces the main corridor, and behind it is the private laboratory, with doors opening on an adjoining classroom and on the bacteriology laboratory. In the latter we found accommodations for twelve students, and equipment which included a drying oven, an electric refrigerator, an autoclave and an incubator. The students' tables are fitted with gas and electricity, and are provided with convenient swinging stools supported by the legs of the table. One feature, common to all the laboratories, is an electric panel-board which furnishes each student with direct and alternating current. A. c. is supplied regularly at 110 volts, and D. c. over a range of 2 volts to 110 volts, at a rate of 2-volt step-ups. The botany laboratory we found at the front of the building.

From the botany section we passed to the field of zoölogy, where we found a similar arrangement of instructor's office and laboratory. Here the surrounding rooms are the general biology laboratory and an upper-class laboratory, which have equipment similar to that of the bacteriology laboratory, with the addition of frog sinks and special dust-proof microscope cabinets. The upper-class laboratory is used by the classes in embryology and histology, and for any extra experimental work which may be carried on by students majoring in this field.

Then, leaving the field of biology, we once more made use of the elevator, and arrived at the second floor and the departments of physics and chemistry. The east wing houses the physics department, with its instructor's office, private laboratory, classrooms, and student laboratory. The physics instructor's laboratory is honored above the others in the building because it contains the main electric panel-board, with its twenty-eight separate circuits for the physics laboratory, charger for twenty-four storage batteries, control switch for the D. c. generator, rheostats, and ammeters.

The student laboratory we found to have accommodations for twenty-four students at a time at six tables, which are equipped with swinging seats and are supplied with direct and alternating current and gas. Cases extending around the room contain the equipment and apparatus for the department, and on the two exposed sides

NATURAL SCIENCE LIBRARY



INORGANIC CHEMISTRY LABORATORY

ORGANIC CHEMISTRY LOCKER

LOUISE C. BUHL HALL OF SCIENCE
PENNSYLVANIA COLLEGE FOR WOMEN

of the laboratory there are desks also equipped with gas, air, vacuum, and hot and cold water. Our attention was here called to the lengths of $^3/_4$" pipe, which project vertically from the ceiling, two above each table, and are in reality the stems of T-pipes imbedded in the beams of the attic. These lengths of pipe, which will support a weight of 150 to 200 pounds, are used for suspension of such apparatus as pulleys and pendulums. The course of our wanderings was here checked for a time before the master clock, which operates all the secondary clocks on the campus and which controls the class bells. Its special feature is a mercury-arc attachment for the accurate recording of small intervals of time, of particular use in the carrying out of physical experiments. Because of this attachment, the clock is practically unique, the only other five in the world being owned and operated by the Radio Corporation of America for transoceanic broadcasting and for time signals.

After we had gazed our fill at this unusual piece of mechanism we passed on to the link between the departments of physics and chemistry—the balance room, which has no entrance from the corridor, but only through the laboratories belonging to the two departments. Its indirect lighting, with a double reflection from the ceiling, insures the utmost possible accuracy in the reading of the balances.

With this intermediary step we passed directly into the realm of chemistry via the analytic and organic laboratory, which can accommodate thirty-two students, sixteen at one time. The desks, of which each student has two, are a modified Fales section type, and are equipped with compartments for the complete and efficient housing of all types of apparatus. We were especially proud to learn that the design for these desks had been made by DR. E. K. WALLACE, head of the department of chemistry. This we knew also, was only one of the countless provisions which he had made in a supervision of the plans and construction of the building so complete that we might be pardoned for referring to it as "Dr. Wallace's building." Moving on, we noted that the desk tops were of alberene stone, which is used throughout the chemistry department, the laboratories in the other departments having acid-treated wood desk tops. In this laboratory each student has a working space of four feet by two and a half feet, with the following conveniences: an individual Sheldon-type hood for the removal of gases both heavier and lighter than air, steam, gas, air, vacuum, cold water for use in condensation, a sink with hot and cold water, individual A. C. and D. C. plugs, an individual reagent shelf, a draw-board, and a stool, which, when not in use, is swung underneath the sink. As we walked about the laboratory on our voyage of discovery we unearthed other features: a wall hood of the Cornell type with all conveniences, a wall work-table and an overhead shower. All the distilled water for the laboratories is furnished by a still operated in the attic, which empties into a thirty-gallon container, and is transported to the various floors through aluminum alloy pipes.

Leaving this laboratory, which was, we hoped, soon to be the scene of our labors, we passed through the instructor's office and private laboratory and found ourselves in the physical chemistry laboratory. This small room, with accommodations for sixteen students, has equipment similar to that of the organic laboratory, with the addition of a work table and additional cupboard space for the reception of physical chemistry apparatus.

Immediately we were in the inorganic laboratory, which takes up the rest of the west wing. It is equipped, like the other laboratories, with the modified Fales section desks, here with but one desk to a student. Accommodations in this laboratory are made for eighty-four students, twenty-eight at a time. The desk conveniences are the same as in the other laboratories, save that there are no steam or air outlets, and the amount of desk space per student is three feet by two and a half feet. Along the entire west side of the room runs an eighteen-inch balance

shelf, while the north side boasts a long wall hood, Cornell type, and a work table. Immediately adjoining is a preparation room, with a large hood, cabinet space, and shelves for reagent bottles. Next to the preparation room we found another instructor's office, which is equipped with a photometer table, and may also be used as a dark room for the carrying out of light experiments.

Farther down the hall, on the north side of the corridor, is a smaller chemistry lecture room, with a demonstration desk and moving-picture equipment. Adjoining it is a restroom with an additional hundred lockers.

Now our tour was over. We couldn't bear to leave the new building, in which we were soon to spend so many hours. Instead of departing we kept on peering into corners, opening drawers, asking innumerable questions. "How do the supplies come up from the stockroom?" "Your order slips may be sent down to the ground floor by pneumatic tubes, or you may telephone down your wants, and the supplies will come up on the elevator," we were told. "What are the floors made of?" was the next inquiry, and we learned that they were of Johns-Manville mastic. "How much are the apparatus and supplies of the building worth?" Between $15,000 and $20,000," was the answer. "Shall we ever have an opportunity to do graduate work in science at P. C. W.?" came next, and we were gratified to know that in the near future this may be possible.

At last, and all too soon, we were obliged to leave, and as we flocked out through the blue-green doors, our minds were a jumble of statistics, names, and details. But through all this welter of information, we carried away with us the dominant impression of light, airy classrooms and laboratories, with equipment complete to the smallest crucible, and we made a firm resolve that nothing but good work, worthy the name of science, should ever be done in our already beloved Louise C. Buhl Hall of Science.

RESEARCH REPORTS FROM THE MEETING OF THE A. C. S., BUFFALO, AUGUST 31–SEPTEMBER 4, 1931

Symposium on New Research Tools

A small boy holding a burning-glass in the sun until he gets a smoking hole through a piece of paper—or the sleeve of his best Sunday shirt—is using, on an elementary scale, one of the newest tools of chemical research. For chemists have been catching sun-power through concentrating concave mirrors and raising samples of materials to be analyzed to intense heat, almost like that of the sun's surface itself, by this adaptation of the toys they themselves used when they were boys. At the fall, 1931, meeting of the American Chemical Society DR. ROBERT B. SOSMAN, industrial chemist of Kearney, N. J., told of this, among other new and powerful tools used by the chemist to wrest vivid secrets from inanimate matter and thus to make it more responsive to his will and more useful to the world.

The principle of another bit of boyhood play is used in the ultra-centrifuge method, described by J. B. NICHOLS of Wilmington, Del. We all remember how we used to tie a string to a little bucket, fill it with water, and whirl it round our heads without spilling a drop. This seeming miracle, we now know, was due to centrifugal force, which we built up until it was greater than the force of gravity and hence prevented the water from falling. The same kind of thing is done, only much more intensely, by machines called ultra-centrifuges. These build up forces from ten thousand to a hundred thousand times as great as that of gravity, and separate into larger and smaller fractions, or heavier and lighter portions, liquids mixed with the most stubborn intimacy.

As children we sometimes used to build little furnaces, and when a jet of fire or smoke would purl out of a crack we would blow at it, tap it with our fingers, and

perform other primitive physical and chemical research without knowing what we were really doing. A third of the newest tools of chemical research, described by DR. JOHN BRADSHAW TAYLOR of Schenectady, N. Y., is rather reminiscent of this childhood amusement. It is called the "molecular beam" method. It consists of putting the material to be investigated into a furnace with a narrow slit in its wall, tormenting it with heat until its molecules come flying out of the slit like the proverbial bat out of a bake-oven, and then turning magnetic and other forces on them to see what they do as they rush by. Differences in behavior of course indicate differences in nature, interpretable by the skilled eye of the chemist.

We also used to judge the heat of the old kitchen stove by looking at it. There were at least three degrees of heat: "still black," "red hot," and "white hot." A new instrument used by chemists interested in problems of high temperature improves on this. As described by DR. L. R. KOLLER, also of Schenectady, the instrument substitutes a tube lined with a thin film of metal which is sensitive to light, and changes its resistance to electricity in proportion to the intensity of a beam falling on it. Light from material in a furnace, undergoing the ordeal of analysis, is focused on this tube. The minute changes in electric current are magnified by passing them through a series of vacuum tubes, so that they will register themselves big enough to read. This method, depending on the fact that the intensity of light from a glowing hot substance changes sixteen times as fast as the temperature changes, is much more sensitive than methods hitherto in use, which depended on the human eye and on human judgment.

Findings in Fuel Research

Although American crude oil is now so cheap as to be causing acute economic distress in several oil fields, the supply is not inexhaustible and chemists are looking to the day when we shall have to make gasoline and lubricating oil out of coal, as they are already doing in Germany and other European countries.

A series of experiments on soft coals from both eastern and western United States fields were described by PROFESSOR H. K. BENSON and his associates at the University of Washington. The process consisted of subjecting coal to pressures from 2200 to 4200 pounds per square inch, at temperatures from 200 to 450 degrees Centigrade in the presence of water vapor. The oily mixtures obtained by this procedure compared favorably with the product of European coals treated in the same way, the report stated.

We commonly think of even soft coal as pretty hard stuff. Yet coal is a jelly—a colloid, to use the strictly scientific term. Evidence to this effect was adduced by DR. REINHARDT THIESSEN of the U. S. Bureau of Mines. Using a new ultra-power lens on his microscope, Dr. Thiessen has seen the "micellae," or ultimate visible particles that go to make up coal, and he had found them to be similar in size and shape to the micellae of plants, which of course were the raw material of coal, ages ago. The colloid nature of coal has long been suspected, but until now definite proof had been lacking.

Gas, for fuel of high heating value, has been made experimentally by two Illinois chemists, DRS. C. S. BORUFF and A. M. BUSWELL, using a most unpromising material—"beer slop" from distillery waste produced by industrial alcohol factories. Dr. Buswell has built up a reputation for getting gas from all sorts of waste products, such as sewage and chopped-up cornstalks.

Symposium on Endocrine Therapy

Diabetic patients can safely be given sugar and starchy foods to eat, if fats are carefully eliminated from their diet. This method of handling diabetes cases, unorthodox according to prevailing medical views, has been successfully used by DR. I. M. RABINOWITCH, of Montreal General Hospital. His paper was part

of a symposium on "some clinical aspects of endocrine therapy."

There is no cure for diabetes, in the real sense of the word, Dr. Rabinowitch emphasized. All that modern methods of treatment do is arrest the disease and prolong the patient's life, sometimes for many years. Even since the discovery of insulin, it has been found that a properly adjusted diet alone is sufficient in the majority of cases.

In the cases treated by Dr. Rabinowitch, the patients were allowed sugars and starches enough to satisfy their energy requirements, but only enough, and insulin injections were given only when specially needed, and then often in reduced dosages.

Physiological evidence has been advanced by DR. E. V. MCCOLLUM, one of the pioneers of insulin research, that the breakdown products of fats are more harmful to the body tissues than are those of sugar, and that they are responsible for some of the symptoms of diabetes. It would seem logical, therefore, to change the standard diet for diabetics by cutting out fats and allowing them carbohydrates. Subscribing to this view, Dr. Rabinowitch made his clinical tests, with the success he described.

Another contributor to the same symposium was DR. J. P. PRATT of the Henry Ford Hospital in Detroit. He described clinical tests of two ovarian extracts as remedies for a number of physiological disorders of women. Finding hypodermic injections troublesome, he tried administering the extracts by means of the nasal spray and found that they could be successfully absorbed through the mucous membranes in this way. Encouraging results were obtained in a number of cases. But they were not sufficiently uniform to justify any sweeping conclusions. One discovery was that some cases could be materially benefited because the patient believed the treatment was doing her good, even though a neutral drug was substituted; that is, the ailment was more psychological than physiological, and the cure was correspondingly wrought in the mental rather than in the physical field.

Other contributors to the symposium were DR. ALLEN W. ROWE of the Memorial Hospital in Boston; DR. L. G. ROWNTREE of the Mayo Clinic, Rochester, Minn.; DR. WILLIAM ENGLEBACH of New York City, and DRS. R. G. HOSKINS and F. H. SLEEPER. The latter research team described new methods in treating some forms of insanity with extracts from the ductless glands.

The Chemistry of Fats

The fat man who tells you, "no matter how little I eat, I gain weight anyhow," is doomed to lose that convenient alibi. Researches on the internal chemistry of fat folks, reported by DR. L. H. NEWBURGH of the University of Michigan Hospital, have not shown any metabolic abnormality that would have this effect. Dr. Newburgh's investigation included a careful check-up on the intake of energy-producing foods, the exchange of energy within the body, and the amount of water absorbed and lost by the stout subjects of his research. He found them normal in all respects. The discomforting conclusion therefore remains, that the only way to get too fat is to eat and drink too much.

Another investigation of the chemistry of getting fat was reported by DR. WILLIAM E. ANDERSON of Yale University. He was particularly concerned with the problem of where the fat comes from, and traced the story of the upbuilding of body fat out of the fragments of sugars and starches. He also hinted at the probability that even proteins, those lean-meat and whole-wheat constituents that are supposed to be the dieter's stand-bys, can be at least to some extent split apart and reassembled into fats.

The smallest visible living things, bacteria, are storers of fat—more notably so, indeed, than humans or hippopotami or whales. Some of them build up a fat content of from twenty to forty per cent of their total body weight, PROFESSOR R. J.

ANDERSON, also of Yale, said. But bacterial fat is not like the fats of the higher plants and animals. The latter consist of combinations of glycerin with one or more acids. The fatty acids of bacteria are peculiar substances with very large molecules. Injected into normal animals, these bacterial fats stimulate the formation of certain types of cells in excessive amount, leading to the building up of tubercular tissue. Professor Anderson credited this peculiar physiological activity on the part of bacterial fatty substances to the big-moleculed acids they contain.

Progress in Rubber Research

That oxygen causes the breakdown of rubber being milled in the course of manufacture was brought out in a report by W. F. BUSSE, Akron, Ohio. The action of oxygen on the long molecules of rubber breaks them up into shorter ones and causes the rubber to soften. With the use of a photographic plate the presence of peroxides, the breakdown products, was detected.

The process of oxidation takes place rapidly, especially in cold milling. The rollers have the effect of twisting the minute rubber molecules and making them easier victims of attack by the oxygen. As a check on this oxidation theory, milling was performed in the absence of oxygen. Little, if any, breakdown was said to occur.

Evidence obtained from the use of the X-ray in regard to the nature of rubber was presented by M. F. ACKEN and W. P. DAVEY, of Pennsylvania State College, who called attention to the fact that normal rubber acts like formless matter toward X-rays. When stretched, however, it causes a bending of X-rays as would material composed of fibers, or thread-like cells.

The investigators found that this reaction to X-rays did not take place as soon as the rubber was stretched, but only after a short time interval in which the so-called fiber structure could be built up. The conclusion was reached that rubber is both a liquid and a solid: fibers with liquid rubber in the spaces between them. This view explained the delay in reaction. Time is required for the liquid to be squeezed out of the spaces, before the molecules of stretched rubber can assume the position of true fibers.

C. R. PARK, Charleston, W. Va., and R. B. MAXWELL, discussing the rôle of temperature in the vulcanization of rubber, pointed out that the temperature of the inside of a rubber article being vulcanized is much lower than that of the outside because rubber compounds do not conduct heat easily. Factors were determined to show accurately how temperature affects vulcanization when certain substances take part in the process.

J. W. AYERS, of Easton, Pa., reported that traces of free ferric sulfate in oxide of iron have been shown by experiment to hasten the aging of rubber. Effects of various compounds which speed up the curing of rubber or delay its deterioration were recounted by J. H. INGMANSON, C. W. SCHARF, and R. L. TAYLOR, all of New York City.

Rubber balloons, chief ware on circus days, now serve a scientific purpose. In a report by J. R. SHEPPARD and W. J. CLAPSON, of Joplin, Mo., it was shown how the inflated balloon is used for the study of rubber being stretched. The difficulties of compressing rubber were avoided under the method explained, the stretching extending outward in two directions. Measurements as to the actual size of the balloon, the thickness of its wall, and the pressure of the gases inside were taken at various intervals while the balloon was being blown up.

Vitamin Reports

If you have any youngsters of the spinach-refusing age, you may soon be able to offer them the stuff that spinach supplies in a form they may not like any better—to wit: as a powder or a pill. For carotene, a yellow coloring matter that is present in green leaves as well as in the yellow carrots for which it is named, seems to be identical

with the long-sought basic material of vitamin A. By a new process, it can be produced from carrots in highly concentrated crystalline form at low cost, and comparatively rapidly. The discoverers of the new process are DRS. HENRY N. HOLMES and HENRY N. LEICESTER of Oberlin College.

If you dislike both eating spinach and swallowing pills, you can get your vitamin A or your carotene by taking a "shot in the arm," with a hypodermic needle, just as protection against some infectious diseases is now commonly administered. The discovery that the injections are possible was announced by DR. R. G. TURNER of the Detroit College of Medicine and Surgery. He gave such injections to animals suffering from a lack of vitamin A, and compared their rate of recovery with a set of "controls" given vitamin A with their food in the ordinary manner. The injected animals recovered their health.

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One way of getting plenty of the rickets-preventing vitamin D in your eggs is to feed lots of it to the hens that lay them. Experiments indicating this were described by FRANCIS G. MCDONALD and O. N. MASSENGALE. They fed pullets a diet containing cod-liver oil for eight weeks, and then tried oil from their egg yolks on rats. Afterward they gave the same pullets a course of feeding on irradiated ergosterol of 10,000 times the strength of the cod-liver oil, and again fed oil from their egg yolks to rats. They found that the egg yolk oil after the highly concentrated ergosterol feeding was 185 times as effective in preventing rickets as was the yolk oil after the cod-liver oil feeding. But the pullets had to pay. During the ergosterol-fed period they lost weight and laid fewer eggs.

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Vitamin A is assimilated by the body when injected into the muscle or tissues as it is when fed by mouth. Animals deficient in that vitamin returned to normal after such injections using fish-liver oil concentrates, said PROF. ROBERT G. TURNER, of the Detroit College of Medicine and Surgery.

A concentrated form of vitamin C made from lemon juice, useful in preventing scurvy, once the worst enemy of sailors and prisoners, was described by PROF. C. G. KING, F. L. SMITH, and J. L. SVIRBELY, of the University of Pittsburgh. It is extracted with acetone, and the preparation remains active for two weeks if stored with solid carbon dioxide or refrigerated under nitrogen.

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Cranberry sauce has vitamin C like citrus fruits, when it is not cooked too long. It loses nothing when cooked two minutes, but if screened or pulped while hot, it loses 75 per cent of its vitamin value, due to the oxygen of the air which then destroys it. Screening while cold has practically no such effect.

PAUL D. ISHAM and PROF. CARL R. FELLERS of the Massachussetts Agricultural College reported these results.

New Instruments for Measurements

A new "photo tube" which looks into a furnace and measures the heat, was described by DR. L. R. KOLLER of Schenectady, N. Y. A current is set up in the tube by the light it "sees." The brightness of an object varies sixteen times as fast as its temperature; therefore the photo tube current is a very sensitive means of measuring temperature.

A new pyrometer can measure temperatures as low as 1000 degrees Centigrade, and has no upper limit, Dr. Koller said. It is instantaneous, and is not injured by the furnace or its contents. This is a very needful apparatus in these times of high temperatures in modern industrial processes. Lack of adequate means of measuring high temperatures in furnaces has handicapped their use.

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It is now possible to measure pressures as high as 600 atmospheres, or 9000 pounds per square inch, with an error of only one part in ten thousand, said DR. F. G. KEYES of the Massachussetts Institute of Technology. The device used is a "dead weight gage" or piston.

The Rôle of Manganese

Lettuce grown without manganese was stunted, and when it was fed to baby rats as a source of this metal in the diet, they made fifty per cent less gain in weight than rats fed normal lettuce. The experiments was described by PROF. J. S. MCHARGUE, chief of the Kentucky Agricultural Experiment Station, at Lexington, Kentucky, W. R. ROY, and R. K. CALFEE.

Decay of algae, which are low forms of water plants, together with decomposition of other organic material, is responsible for increased concentration of the mineral manganese in some drinking waters. The acidity of the water examined is increased by the decomposed matter, and to this acidity is due the dissolving of the manganese. This discovery was made by EDWARD S. HOPKINS and GEORGE B. MCCALL, who made a careful study of the water supply of Baltimore. Samples of water from the 23,000,000,000-gallon reservoir were taken weekly for about two years. The bottom of the water contained the manganese, and with the seasonal turnover was brought to the top to be used as a part of the city's supply.

For the past few years it had been noted that this supply underwent an increase in manganese, beginning in late October and continuing until January of each year. This was the manganese which went into the solution during the summer season. Heretofore, the mystery of the manganese in the water supply had defied satisfactory explanation.—*Science Service*

ELECTRONS SPEED WITHIN DENSE SOLIDS

A method used by astronomers to determine the velocity of stars has been applied in a slightly modified form to the atom to furnish the first direct evidence that electrons, negatively charged electrical portions of atoms, move about at high speeds in solid bodies. The experiment, conducted at the California Institute of Technology by DR. JESSE W. M. DUMOND, research fellow, and DR. HARRY A. KIRKPATRICK, teaching fellow in physics, was the second crucial test of activities of the electrons within the atom. The first test was reported last January.

In explaining the application of the Doppler effect to the experiment, Dr. DuMond declared that if the source of the light or sound is in motion the successive vibrating waves or ripples are crowded together on the forward side of the motion's direction, and spaced farther apart on the rearward side. A similar phenomenon explains the fact that the sound from a train whistle approaching a stationary listener is of higher pitch than the sound of the same whistle when the train is receding from the listener. In the same way, stars approaching an observer emit spectral lines shifted toward the violet end of the spectrum, whereas receding stars emit lines shifted toward the red.

When the electron scatters X-radiation a similar effect occurs. If that part of the radiation which is scattered at a definite angle to the incoming beam is observed with a spectroscope, the spectral line which was in the original radiation is found to be shifted toward longer wave lengths and broadened. The shift may be regarded analogically as a Doppler effect caused by the velocity of the electron recoiling away from the light under the impact that the light has given it. The increased breadth of the line may be regarded as a composite Doppler effect of the chaotic motion of all the electrons in the myriads of atoms scattering the X-radiation.

Dr. DuMond set the average speed of the invisible electrons which make up solid matter at 1500 miles per second for the case of carbon. The experiment, which required months of work on the part of Drs. DuMond and Kirkpatrick, not only throws more light upon the internal activities of an atom, but proves two predictions made by Dr. DuMond in 1929.

Dr. DuMond's predictions were: first, that in the spectrum of X-rays scattered by solids of low atomic number the breadth of the Compton shifted line would be proportional to the sine of one-half the

scattering angle; and second, that it would be proportional to the primary wave length.

The latest experiment testing the second of the above predictions was conducted with the multi-crystal spectrograph developed at the California Institute of Technology. Measurements were made of characteristic X-rays from molybdenum, silver, and tungsten scattered by carbon at an angle of 156 degrees. Spectrum photographs were made of the radiation from each element. Each exposure lasted 1000 hours.

Dr. DuMond based his predictions two years ago upon the hypothesis that the breadth of the shifted line in the spectrum of scattered X-rays is caused by the movement of electrons in atoms. The fulfilment of the two predictions is therefore confirmatory evidence for the hypothesis on which they were based. Details of the experiment will be published soon in *Physical Review.—Science Service*

SYNTHETIC ANTISEPTIC IS NEW HOOKWORM AND ASCARIS REMEDY

A safe and apparently certain treatment for hookworm has been found in the synthetic antiseptic, hexylresorcinol. This important discovery in the field of medicine was announced by DR. VEADER LEONARD of the School of Hygiene and Public Health of The Johns Hopkins University, Baltimore, Maryland, before the Section on Tropical Medicine of the Third Pan-American Medical Congress recently.

Dr. Leonard himself first described the bactericidal properties of the drugs, but not the fact that it is effective against hookworm and ascaris. Since 1924 it has been known that the synthetic chemical, hexylresorcinol is seventy times stronger than carbolic acid and at the same time practically non-toxic to man. It has been used as a general as well as internal antiseptic the last few years.

DR. PAUL D. LAMSON, professor of pharmacology at the Vanderbilt University School of Medicine, discovered its potency in hookworm disease and ascariasis while investigating the problem of safe remedies. The work was sponsored by the International Health Division of the Rockefeller Foundation.

Hookworm, the "disease of backwardness," is one of man's oldest diseases, for its symptoms are apparently described in ancient Egyptian papyri. In present times it is claimed that one-half of the world's population lives in areas where it is prevalent. Millions of people are infected by it, and the havoc it does is incalculable. It is a disease that could really be controlled by hygienic means, Dr. Leonard stated, but it is difficult to obtain the cooperation of the masses affected by it. The ignorance of the classes that generally have it is the stumbling block.

"The statement can be made without reservation," Dr. Leonard said, "that there is not a single anthelmintic (antiworm) drug now in common use, which has not caused prompt fatalities by the administration of average doses." Because of its dangers, the use of thymol has been largely superseded by carbon tetrachloride, a common cleaning fluid, but carbon tetrachloride may prove fatal in small doses to persons deficient in calcium.

Santonin, a classic remedy for ascariasis, infection by common roundworms, is one of the most expensive drugs in the pharmacopeia, and may produce serious poisoning in very small doses, while it may be fatal in average doses. Oil of chenopodium, given in place of this drug because of its expense, has to be given with care to debilitated persons. Many fatalities have occurred for its toxicity varies and it has never been standardized.

The problem in America, Dr. Leonard says, is largely a matter of the control of the two parasites, hookworm and ascarides, or common round worms. Both carbon tetrachloride and oil of chenopodium are specific against only one of these parasites, while many patients have both. Treatment with carbon tetrachloride is sometimes dangerous. While it may kill the hookworms, it irritates the ascarides and causes them to begin a migration to

escape the drug which may be fatal to the patient.

The new drug, hexylresorcinol, is effective against both parasites, and against even a third, *Trichuris trichiura*. The chemical is easy to take, has no bad after-effects, and seems to be one hundred per cent efficient when directions are followed. It is effective in this instance only in its crystalline form, made into sugar-coated pills. Four-tenths of a gram is enough for children under six, while one gram is enough for persons twelve or over. It must be taken on an empty stomach and no food should be eaten for four hours afterward.

Dr. Leonard does not yet know whether this drug will be as effective against European hookworm as against the American, or less so as is true of carbon tetrachloride. It is not known whether it will be useful against other nematodes parasitic to man, and cestodes. Present results are based on experiments made with about 1500 persons in the United States. Other investigations now on foot in Japan, China, the Philippine Islands, India, Siam, Egypt, the southern part of the United States, and Mexico may answer these questions.—*Science Service*

COMMON WATER PURIFIER PREVENTS "ATHLETIC FOOT"

A common chemical used in purifying city water supplies, sodium hypochlorite, has been found to be an effective preventive of ringworm infection of the feet by two Buffalo workers in medical research, DR. EARL D. OSBORNE and MISS BLANCHE S. HITCHCOCK. This disease, also known as "athletic foot" and similar nicknames, has spread spectacularly with the post-war rise of sports involving the use of common dressing-rooms and other gathering-places where athletes trample around barefooted for a time. There the spores of the fungi that cause the disease are spread from foot to foot, later causing irritation, cracks, and itching watery blisters.

Dr. Osborne and Miss Hitchcock state in their report to the official publication of the American Medical Society that they have not been able to find a record of sodium hypochlorite being used or suggested as a fungus-killer before. They made some preliminary trials with cultures of various fungi in test tubes, using solutions of the chemical in concentrations stepped up from one-thousandth of one per cent to one-half of one per cent. The latter concentration seemed the most effective, and was chosen as standard for a clinical trial.

With the coöperation of the physical training department of the Buffalo high schools, heavy rubber pans were installed in all the gymnasiums, and students going to and from gymnasium were required to wash their feet in one-half per cent solution of sodium hypochlorite. The solution was renewed every day. In a new high school a shallow "well" for the solution was built into the corridor passing from the dressing room to the showers. Later, the strength of the solution was increased to a full one per cent because of possible dilution through use.

The results of the experiment are reported as most encouraging. The spread of the infection was completely checked. "Our records fail to show a single new case, although numerous ones have appeared from the surrounding towns," the two experimenters report.

The hypochlorite solution, however, is not to be looked upon as a cure for already established cases. The report continues: "So far as cure of the disease is concerned, we do not believe that 0.5 per cent solution hypochlorite or even 10 per cent sodium hypochlorite would be any more efficacious in curing an established case than any other methods employed at present in the treatment of this stubborn condition."

The sodium hypochlorite treatment is the second efficacious prevention for ringworm of the feet reported recently. A short time ago Dr. W. L. GOULD of Albany, N. Y., described how he had stopped the spread of the disease in the junior high school there with a 10 to 15 per cent sodium

thiosulfate solution. Dr. Osborne and Miss Hitchcock, however, believe that their sodium hypochlorite solution offers certain advantages. It is cheaper, and when the quantities used in gymnasiums and similar places are considered, this is a distinct advantage.

Furthermore, they state, in most city water supplies there is already present a little sodium hypochlorite. This reacts with the sodium thiosulfate, forming sodium sulfate and sodium chloride. The slight weakening of the disinfecting solution which thus takes place may be a minor matter but, it is pointed out, "carrying of this chemical into the pool may have disastrous consequences because of the reduction of the sodium hypochlorite to sodium chloride."—*Science Service*

RESEARCH ON PAPERBOARD CONTAINERS AT MELLON INSTITUTE

DR. EDWARD R. WEIDLEIN, Director, Mellon Institute of Industrial Research, Pittsburgh, Pa., has announced that an industrial fellowship for research on moistureproofing and greaseproofing paperboards used in cartons and boxes has been established in that institution by the ROBERT GAIR COMPANY of New York, N. Y. Recent progress in package merchandising has indicated, he pointed out, a growing need for paperboard containers with improved moistureproofing and greaseproofing qualities, and he said that it is the hope of the Robert Gair Company, the donor of the fellowship, and of Mellon Institute, that technically valuable advances will result from the studies which were begun on September 1.

DR. MARION D. COULTER has been appointed a Fellow of the institute, to conduct these scientific investigations. He is a specialist in organic chemistry and during the period 1925–1930 held a Mellon Institute fellowship for the study of certain problems in cellulose technology.

According to Dr. Weidlein, Dr. Coulter's new research on perfecting moistureproof and greaseproof paperboards for packages will be of interest to many industries. If successful, the investigational developments are expected to make possible important economies and improved efficiency in distribution, as well as to act as a further stimulus to the growth of package merchandising.

BRASSEUR, YOUNG BELGIAN SCIENTIST, TO WORK WITH LANGMUIR PRIZE WINNER

DR. HENRI BRASSEUR, 26-year-old Belgian scientist who has won his fourth fellowship, entitling him to three months' research at the California Institute of Technology, will work with DR. LINUS C. PAULING, first winner of the Langmuir prize for outstanding contributions.

Dr. Brasseur, an assistant in physics at the University of Liége, won his first scholarship in 1927 when he went to Paris, followed by other prizes that enabled him to study in Zürich and Manchester, England. He will endeavor to devise a photographic method whereby he can obtain absolute intensity measurements of X-ray deflections in crystals. Dr. Pauling, an associate professor in theoretical chemistry at the Institute, will be his advisor.—*Science Service*

GRASSELLI MEDAL TO L. V. REDMAN

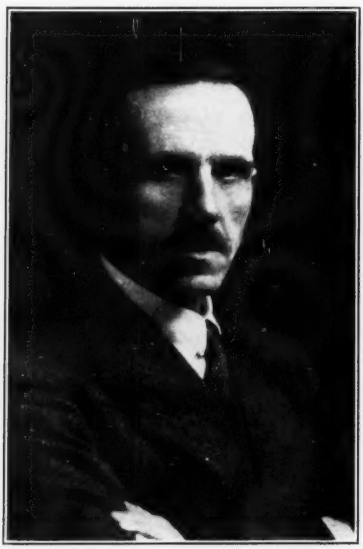
The Grasselli Medal will be presented to L. V. Redman, president-elect of the American Chemical Society, by vote of the Grasselli Medal committee of the American section of the Society of Chemical Industry, at a joint meeting of the New York chemical societies on November 6 next.—*News Edition, Industrial and Engineering Chemistry*

PROFESSOR DESCH TO LECTURE AT CORNELL UNDER BAKER FOUNDATION

The non-resident lecturer in chemistry at Cornell University for the present university term on the George Fisher Baker Foundation is PROFESSOR CECIL HENRY DESCH, who has held the professorship of metallurgy in the University of Sheffield

up to last June, but who, on his return to England next February, will enter upon the position of superintendent of the metallurgical department at the National Physical Laboratory at Teddington, a suburb of London.

Professor Desch was born in London in 1874. He studied chemistry at Finsbury Technical College under PROFESSOR R. MELDOLA, at Würzburg University under PROFESSOR A. HANTZSCH, and at University College, London, under SIR WILLIAM RAMSAY. He had eight years experience



in chemical works, mainly in the field of organic chemistry.

In 1902 he was research assistant in metallography to PROFESSOR A. K. HUNTINGTON In 1909–1918 he held the Graham Young Lectureship in metallurgical chemistry at the University of Glasgow, and from 1918 to 1920 was professor of metallurgy in the Royal Technical College, Glasgow, going from there in 1920 to the University of Sheffield as professor of metallurgy, where he also occupied the position of dean of the faculty. He is a fellow of the Royal Society, in 1925 was president of Section B (Chemistry) of the British Association, president of the Faraday Society 1926–1928, delivered the annual lecture before the American Institute of Metals, New York, 1927, delivered the May lecture of the Institute of Metals in London 1928, is vice president of the Iron and Steel Institute, president of the Cutlery Research Association, member of the council of the Institute of Metals, Non-Ferrous Metals Research Association, Cast Iron Research Association, Institute of Sociology, and member of the executive committee of the National Physical Laboratory.

He has written a textbook of metallurgy which has gone through four editions, a book on the chemistry and testing of cement, and another on intermetallic compounds.

The general topic of his lectures during the present term is The Chemistry of Solids, and under this general heading he will discuss the cohesion of solids; residual affinity at the surface of crystals and the influence of adsorption on growth; chemical attack and etch figures; chemical changes in solid solutions; Widmanstätten and Martensitic structures; the chemical properties of open-packed structures.

PITTSBURGH SECTION, A. S. S. T., SPONSORS METALLURGY COURSE

According to *The Crucible*, the Pittsburgh section of the American Society for Steel Treating is conducting a series of lectures on basic principles of metallurgy at the H. C. Frick Teacher Training School, Pittsburgh, Penna., September 8 to December 15, inclusive. The schedule of lectures is as follows: "General Principles of Physics and Chemistry as Applied to Metallurgy," C. H. HERTY, JR., U. S. Bureau of Mines; "Pyrometry and Fuels," E. G. HILL, Lukens Steel Co.; "Refractories and Furnaces," J. SPOTTS MCDOWELL, Harbison-Walker Refractories Co.; "Manufacture of Iron and Steel," C. H. HERTY, JR.; "Metallurgical

Terms, Crystallization and Metal Structures," and "Structures and Properties of Pure Metals, and Hot and Cold Working," S. L. GOODALE, University of Pittsburgh; "Alloys, Their Structures and Properties," V. N. KRIVOBOK, Carnegie Institute of Technology; "The Iron-Carbon Diagram," and "Plain Carbon Steels," NORMAN WOLDMAN, Westinghouse Electric and Mfg. Co.; "Heat-Treating Operation," N. I. STOTZ, Braeburn Steel Corp.; "Mechanical Shaping of Metals," J. A. SUCCOP, Heppenstall Co.; "Alloy Steels," V. N. KRIVOBOK; "High-Speed and Stainless Alloys Steels," J. P. GILL, Vanadium Alloys Steels Co., "Wrought Iron, Cast Iron, and Cast Steel," DR. JAMES T. ASTON, Carnegie Institute of Technology; "Physical Testing of Metals," R. L. TEMPLIN, Aluminum Company of America.

METALLURGICAL ADVISORY BOARD HOLDS ANNUAL MEETING AT CARNEGIE INSTITUTE OF TECHNOLOGY

The fifth annual open meeting of the metallurgical advisory board to the Carnegie Institute of Technology and the U. S. Bureau of Mines was held on Friday, October 16, at Carnegie Institute of Technology, Pittsburgh. Progress made on research problems undertaken jointly by Carnegie and the Bureau of Mines was discussed during the morning and afternoon sessions by investigators from the two laboratories.

MR. CHARLES F. ABBOTT, executive director of the American Institute of Steel Construction, Inc., was the principal speaker at the evening session following an informal dinner at the Hotel Schenley. Mr. Abbott's subject was "Market Research in the Steel Industry." DR. THOMAS S. BAKER, president of the Carnegie Institute of Technology and organizer of the advisory board, presided at this session.

This morning meeting was devoted to reports and discussions on iron-manganese-carbon alloys and chrome-nickel alloys. Reports on research work were given by DR. FRANCIS M. WALTERS, JR., director of the Bureau of Metallurgical Research; DR. V. N. KRIVOBOK, metallurgist of the same bureau; and MAXWELL GENSAMER and CYRIL WELLS, assistants. DR. C. H. HERTY, JR., physical chemist, and M. B. ROYER, assistant metallurgist, of the Bureau of Mines, gave a report on the solubility of carbon in iron-manganese-silicon alloys. DR. G. R. FRITTERER, associate metallurgist of the Bureau of Mines, reported on the electrolytic method for the determination of inclusions in steel.

The physical chemistry of steel making was reported on and discussed at the afternoon session. The three outstanding contributions from this work are the development of a new manganese-silicon deoxidizer, which has been shown to be much superior to ferro-manganese ferro-silicon in combination in producing clean steel at a low cost; the development of a method for quantitatively determining non-metallic inclusions in plain-carbon steels; and the determination of the factors which affect the oxidation of steel in the open-hearth furnace. These reports were made by Dr. Herty and members of the Bureau of Mines staff.

Harvested Vegetable Must Breathe to Keep. Succulent vegetables must breathe oxygen after they are harvested or they will deteriorate in flavor, said Dr. Edward F. Kohman and N. H. Sanborn of Washington, D. C., at the meeting of the American Chemical Society. Bruising tissues of vegetables by rough handling, treating them with saturated salt solution, or freezing them, makes the cells unable to take in oxygen from the air. They continue to give off carbon dioxide, however, and lose sugar. Storing them out of contact with oxygen has the same effect, and off-tastes develop.—*Science Service*

Recent Books

A Laboratory Manual of Gas, Oil and Fuel Analysis. CARL J. ENGELDER, Ph.D. University of Pittsburgh. John Wiley and Sons, Inc., New York City, 1931. x + 236 pp. 50 Figs. 15 × 23 cm. $2.75.

The book is designed for students and others interested in gas and fuel work.

The reviewer regrets to have found a number of errors, omissions, and cases of bad practice as follows: pp. x and 232, "carbon monoxide may be made by treating oxalic acid with H_2SO_4": the information is not given that an equal volume of CO_2 is produced, which in making up a gaseous mixture is important. For the confining liquid in the Hempel apparatus, strong brine is recommended: this is messy, attacks iron stands and brass pinchcocks, short-circuits electrical apparatus in explosions and combustions; Hempel's suggestion to saturate the buret water with the gas to be analyzed is far better.

The attaching of a short piece of tubing to a pipet containing strong potash solution and blowing into it (p. 5) is dangerous; an empty bulb or bottle should always be inserted in the line. In making explosions, bystanders and operator are protected from possible danger by a glass plate or fine wire gauze screen between them and the apparatus. In over 40 years of teaching, the writer has known of but two cases in which the pipet broke, and has never heard of using goggles in any laboratory—they would seem to be superfluous—but the apparatus must be shielded. The precautions regarding gas explosions are incomplete. Orsat apparatus with the glass stopcocks is the only type described, no mention being made of the hundreds of this apparatus sold by the Hays Company using pinchcocks or metal stopcocks. Shepherd's recent gas apparatus also is not mentioned. In using the Junker's calorimeter, three men are too many, one *can* do it alone, but two work better, changing stations after each run. It is to be noted that good checks are possible with the carbon residue determination, p. 158. Sulfur in coal would be better determined by the Jackson or Parr turbidimeter as it is in practice, than by the tedious gravimetric method. Descriptions of apparatus or methods are insufficient, as in the case of the wet meter, the methods of coal sampling and determination of carbon monoxide (Exp. 16): no reference is here made to the "Hoolamite" procedure.

There is also considerable duplication of experiments, as for example the determination of CO_2 and O_2 (Exp. 2); of CO_2, O_2, and N_2 (Exp. 3) and the analysis of flue gas (Exp. 8). A similar case occurs with Exp. 9, 10, and 11. Calculations are repeated, pp. 24 and 33, pp. 85–6, and 113. In some cases the style is too diffuse: the material on flue gases, etc., on pp. 68–74 could have been given in half the space and the typical analyses tabulated.

Some experiments are so simple as to lead one to question the wisdom of their inclusion: *e. g.*, the sp. gr. of gases, relative humidity, and the color of gasoline, which is unimportant.

The preparation of all reagents should be given in the appendix and not scattered throughout the book, for example pp. 3, 8, 11, 139, etc. The method of preparation of starch indicator (p. 94) is incorrect.

For the advanced student or practical man, references to periodicals are indispensable: more of these could well have been included, as on page 80. The work is generously supplied with tables, these and the appendix making about 20% of the volume.

The reviewer was glad to see the use of explosion methods and the Hempel apparatus featured, even though the cumbersome "compound pipet" is recommended. He thinks the value of the book to the industrial man would be increased

by a full statement of the practical applications. An unusual and very commendable characteristic of the work is the large number of questions and problems included in it. Other most excellent features are the abundant, full and clear theoretical explanations and calculations, particularly in the case of combustion analyses: these and the "data forms" will make the volume very useful to those teaching the subject.

A. H. GILL

MASS. INST. OF TECHNOLOGY
CAMBRIDGE, MASS.

The Macmillan Table Slide-Rule. J. P. BALLENTINE, Ph.D., Associate Professor of Mathematics, University of Washington. The Macmillan Company, New York City, 1931. 4 Plates + 4 Slides. 22 × 28 cm. $0.50.

As the name indicates, the Macmillan Table Slide-Rule functions in principle like the well-known slide-rule. It will be recalled that the scales on the slide-rule are logarithmic, so that the addition of two numbers on the scale yields their product. The accuracy of such a slide-rule is limited firstly by the accuracy of the scale, and secondly by exactness with which interpolations can be made. Thus the ten-inch rule is good for four places only at the lower end of the scale. The Table Slide-Rule differs in that the continuous scale of the common slide-rule is replaced by a table of one thousand antilogarithms each to five places, exactly as though the common rule were notched with one thousand equidistant notches permitting only that number of "settings." Although the number of "settings" is restricted, they are close enough to result in no great loss in accuracy. They have the advantage that each "setting" is known to five places.

The Table Slide-Rule consists of four plates—one of 1000 antilogarithms, as described above, for multiplication, one for powers, one for sines, and one for tangents. The "slides" to replace that of the common slide-rule consist of two for multiplication, corresponding to the first plate, one for division, corresponding to the inverse scale, and one for square roots.

A comparison with the common slide-rule and with logarithm tables naturally suggests itself. Any new method of calculation should compare favorably with these either in convenience and ease of manipulation or in accuracy. In the reviewer's opinion, there is more chance of error in handling the Table Slide-Rule than with the common slide-rule, and the manipulation seems more time-consuming. This may not be true where many calculations involving a common factor are made. A five-place accuracy is possible if each number is considered the sum of two numbers, but the evaluation of the resulting quadratic equation involves at least three multiplications and summation of the products. A five-place logarithm table should produce the same accuracy with greater ease. Thus the Table Slide-Rule for ordinary three-place calculations appears not quite so rapid as the common slide-rule, and for the more accurate five-place calculations is not so convenient as the five-place logarithm table. Its superiority appears to lie in its combination in one unit of some advantages of each, so that it may be used to replace both.

The chemistry student who does not easily gain facility in the use of the slide-rule and logarithm tables will find the new rule somewhat more difficult to master. Only one with some skill in quick and convenient methods of calculation will be able to utilize the Table Slide-Rule fully. It will always be disturbing to a novice in calculation not to find the exact number he wishes on the table, and although any resulting error will be negligible, his confidence in the method will not be great. All teachers have seen students who dislike to use logarithm tables because they are not "exact"; those students will find more difficulty with the Table Slide-Rule. For these reasons the new device will find more favor with those who do a considerable amount of calculation and find it convenient to have but one tool

than with those who do only a limited amount of calculation.

The question of cost is not negligible. Many teachers will consider requiring the purchase of the fifty-cent Table Slide-Rule who would not require the purchase of the more expensive conventional slide-rule. There will probably be few converts from the latter, but students who begin with the Table Slide-Rule may become its firm partisans. It is recommended, however, that students in chemistry first acquire facility in the use of logarithm tables, which are an almost indispensable tool for the chemist. The Table Slide-Rule may then be used as a supplement in checking calculations and for three-place calculations in general.

L. E. STEINER

OBERLIN COLLEGE
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The Collected Papers of Carl Wilhelm Scheele. Translated from the Swedish and German Originals by LEONARD DOBBIN, Ph.D., Lately Reader in Chemistry in the University of Edinburgh. G. Bell and Sons, Ltd., London, 1931. xv + 367 pp. 12.5 × 18.5 cm. 10s.

The translator, inspired by an intense admiration for the wonderful chemical genius of the author, has here presented in a single volume translations of the whole of Scheele's papers as these appeared in various scientific journals and also of his famous Treatise on Air and Fire. While separate portions of these writings have appeared in English translations, copies of these have become scarce and the translator has rendered a distinct service to students of chemistry and its history by again placing within their reach these chemical classics. The translation has been well done, a feat of no mean proportions, for Scheele's style is distinctly abrupt and rugged, his sentences are often unduly long and involved; the English rendering has been made as literal as possible, sacrificing, where necessary, elegance to accuracy.

The text has been divided into four sections (1) papers published prior to 1777; (2) Chemical Treatise on Air and Fire; (3) papers published after 1777; (4) minor communications including several letters. The appendix contains a useful glossary of eighteenth century names of substances, with modern explanations or equivalents; and a table of approximate British equivalents for the Swedish and German weights and measures mentioned in the text. The translator has seen fit not to include any biographical material, but has listed numerous notices and memoirs that have appeared in Swedish, English, French, and German, though exact references to the place of their appearance are given only for the English accounts of Scheele's life and achievements.

"To really know and appreciate Scheele, it is necessary to read and study his papers attentively in detail. The reader cannot fail to be struck by the extraordinary profusion of the experiments which these papers record and by Scheele's exceptional ingenuity in devising, and skill in executing, these experiments. At the same time it is impossible not to recognize how continually and seriously his outlook was hampered and his theoretical considerations warped by the dominating influence of the commonly accepted phlogiston theory, to which he was a firm adherent... It is probable that Scheele would have adopted the new (Lavoisierian) system had he lived for a few years longer so as to become familiar with the advances of knowledge, particularly on the quantitative side, upon which that system was founded."

Scheele's discoveries were not only numerous but varied so that every chemist, no matter what his speciality, can here read the original record of some fact of prime importance. Even the beginner will find described experiments which are standard constituents of elementary courses. Teachers can well recommend portions of this translation as collateral reading, and the reviewer feels reasonably

certain that they will wish to do so after they have availed themselves of this opportunity to become familiar with Scheele's own account of his remarkable activities.

RALPH E. OESPER
UNIVERSITY OF CINCINNATI
CINCINNATI, OHIO

Lavoisier. J. A. COCHRANE. Constable and Co. Ltd., London, Eng., 1931. xiii + 264 pp. 20 × 30 cm. 7s. 6d.

This book is an accurate and entertaining account of the life and work of the famous French chemist, Lavoisier. It traces his career from the early days, through his association with the French Academy of Sciences and the *Ferme Générale*, to the troublous period of the Revolution, which finally led to his tragic death. Much material found only in inaccessible books is included in a condensed form.

A careful examination of the book confirms the statement of the publisher that the author "has brought into prominence the events in the life of the great Frenchman, and has rescued from obscurity incidents that strike deep into the foundations of European history." The author is just, though somewhat severe, in evaluating the relation of Lavoisier's experimental work to the discoveries of Priestley and Cavendish. The record of this work is unusually complete and due credit is given the French chemist for his logical treatment of discoveries, his own as well as others, which led to fundamental generalizations, particularly the interpretation of the rôle of oxygen in combustion and respiration.

Lavoisier's ability in the fields of geology, agriculture, finance, economics, literature, education and politics are adequately set forth in language which is lucid and often witty. We are shown vividly the ceaseless activity of Lavoisier in a life marked by generosity, versatility, and usefulness. It is clearly demonstrated that while Lavoisier was an aristocrat by birth, training, and association, he was actually and dynamically a rare combination of aristocracy and democracy, living and working among the élite but coincidentally planning and striving for the good of the common people, be they the unfortunate peasants on his own estate or the potential mobs in the cities.

The suppression of the Academy that was so dear to Lavoisier, the arrest, imprisonment, trial, and execution are depicted in appropriate words, and Mme. Lavoisier's devotion during the last days is described, perhaps too briefly, in a way that shows she was a keen appraiser of her husband's worth and his country's infamy.

We are fortunate in having in this book an adequate, reliable, and balanced story of the man who is often called "the founder of modern chemistry."

LYMAN C. NEWELL
BOSTON UNIVERSITY
BOSTON, MASSACHUSETTS

Physical Chemistry for Colleges. E. B. MILLARD, Professor of Physical Chemistry, Massachusetts Institute of Technology. (International Chemical Series, James F. Norris, Ph.D., Consulting Editor.) Third edition. McGraw-Hill Book Company, Inc., 370 Seventh Avenue, New York City, 1931. viii + 522 pp. 87 Figs. 13.8 × 20.2 cm. $3.75.

This book is a revision of the Second Edition, published in 1927, the original having made its appearance in 1921. The author's aim in writing the book was expressed in the preface to the first edition, namely "to bring before college students certain of the more important aspects of physical chemistry, together with modern data which illustrate the applicability of its laws to the phenomena observed in the laboratory." The prerequisites to an intelligent use of the book by the student are: general inorganic chemistry, quantitative analysis, college physics, and the simple processes of the calculus. The text proposes not only to emphasize "the limitations of the orthodox laws of physical chemistry," but also to impart "an appreciation of the fact that it is an unfinished and growing

science," calling for thoughtfulness and further research. The extent to which the author has achieved his aim may be judged, not only from a critical examination of its pages, but also by the extensive adoption of the text for college courses.

In an attempt to evaluate the merits of a textbook, the reviewer does well to bear in mind the group or class of students for whom it is intended. Professor Millard's course in physical chemistry at the Institute is required, as the beginning course in this subject, of all candidates for the degree of bachelor of science in "pure" chemistry, and in addition of certain groups of students in the applied sciences: namely, metallurgy, geology, and mechanical, chemical, and aeronautical engineering. Teachers of the subject were, doubtless, impressed with the presentation, in the earlier editions, of the important equations without any logical or coördinated plan of deriving them. This policy of the author's may have militated against the adoption of the book in some instances. However, it is consistent with the character of the student to whom the book is directed and for whom the mastery of the minutiae upon which the science rests may be less important than a working knowledge of the principles. It is, of course, pedagogically unsound to place in the student's hands a formula in which the mere turn of an arithmetical crank produces the desired answer. Some teachers of the subject, on the other hand, adopt the opposite extreme, and submerge the physical concepts with so much mathematical formulation, that the student fails to "see the forest for the trees." In the present edition the author has chosen a happy medium, and the objections to former editions have been met in large measure by the incorporation of derivations of most of the important equations. The successful use of this, or any other, textbook will depend upon the presentation of the subject by the instructor, who will necessarily derive the equations and emphasize their assumptions and limitations.

The present text presents a number of desirable additions and corrections to the preceding editions. The chapter dealing with heterogeneous equilibrium, especially the part which treats of phase diagrams, has been entirely re-written. A new chapter on "Radiation and Chemical Change," showing the simple applications of the quantum theory to photochemical processes, a topic of absorbing interest to physical chemists at the present time, is well presented. New sections have been added dealing with X-ray diffraction in liquids, buffer solutions, and the iso-electric point of colloids. Thermodynamic concepts and equations are scattered throughout the book where the subjects demanded. To the reviewer it appears that a separate chapter on thermodynamics in which the concepts are assembled and presented in logical order, together with a derivation of the important equations from them to be used later, would constitute a valuable addition to the book.

Several apparent errors or inconsistencies in definitions have been noted. Definitions, of course, involve a certain degree of arbitrariness, and where the phenomenon is complicated, a definition may be quite inadequate. In many instances, however, definitions are indispensable for the sake of clarity. On page 4, for example, the laws of thermodynamics are stated in terms of a "reversible cycle," a concept which is not defined. The definition of the term "element" (p. 7) would be more consistent if worded: "*have not* as yet *been* decomposed *by chemical means*." In the definition of the international coulomb (p. 23), the term "standard coulometer" is not definite, unless it is indicated that the instrument is a silver coulometer containing neutral silver nitrate solution. (Reference might have been made also to Figure 42.) The international ohm is correctly defined in terms of a mercury column, but the definition in terms of Ohm's Law which precedes it, is only a special case, which holds rigorously for

metallic conduction only, a fact which should have been stated.

On page 63, the expression "Simple" Gas Laws should have read "Ideal" or "Perfect" Gas Laws. We note that the author has chosen to include the Beattie-Bridgman equation of state, which though possessing certain advantages of mathematical form, contains purely empirical constants. It is unfortunate that the equation of Dieterici is omitted, for its constants have the same physical significance as those of van der Waals, and permit, from this equation alone, the calculation of the characteristic properties of the critical point. In connection with the discussion of the Periodic Law, it is worth while to point out one notable exception in the case of the solid elements—namely the property of specific heat, which is *not a periodic*, but a *hyperbolic* function of the atomic weight.

The printing and binding of the book are excellent. It is substantially free from typographical errors. A few instances of careless proof-reading appear in the spelling of proper names; for example, Huygen, Berkley, Bridgeman, Craghoe, Wycoff, Kirschmann, and Bohi.

The book has so many desirable features that its shortcomings are insignificant in comparison. The choice of the illustrative material and the coördination of so heterogeneous a group of subjects in a book of this scope, give evidence of much critical and painstaking effort on the part of the author. The clarity and freshness of style exemplified in this book also reflect a measure of the author's enthusiasm and interest in the subject. The wide variety of excellent problems which the student is called upon to solve, after an intelligent selection of the necessary data from the tables, indicates the thoroughness of mastery of the subject necessary for their solution. The author deserves much credit for producing so splendid a text for the beginning course in physical chemistry.

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An Introduction to the Principles of Physical Chemistry. O. MAASS and E. W. R. STEACIE, McGill University. First edition, John Wiley & Sons, Inc., New York City, 1931. vii + 269 pp. 62 Figs. 15 × 23 cm. $2.75.

As the authors state in the preface, the book is intended for use as a text for a first course in physical chemistry for chemists, chemical engineers, and students intending to enter medicine or the biological sciences. The authors suggest that in the case of chemists the course be taken at the earliest possible stage of training.

The viewpoint of the text is that the basic principles of theoretical chemistry are most important—an idea which is brought out in a well-written first chapter. On the whole, the authors have lived up to this chapter. The first ten chapters are well presented and form a good foundation for more advanced courses in physical chemistry.

Chapters XI and XIII were somewhat disappointing to the reviewer. In Chapter XI the law of mass action is derived from kinetic considerations and the assumptions involved are discussed. The statement is then made (pages 185 and 186) that "...it is also possible to derive it" (the mass law) "from energy considerations. In such a derivation it is customary to use a fictitious 'active mass' in place of the real concentration and thus to *appear* to avoid the inaccuracies of the mass law." This statement is unfortunate, for it is not the energy relations or the mass law which is inaccurate. The difficulty arises from the fact that the free energy changes cannot be accurately related to the concentrations.

In explaining, on page 225, the fall in specific conductance of sodium chloride solutions with dilution the authors state "Presumably there are more ions in two liters of the dilute solution than in one liter of the concentrated solution. This can best be explained by assuming that the dissociation of sodium chloride is not complete..." The statement is one

which the student will have to unlearn later, and to a certain extent the authors attempt to correct themselves on pages 232 and 233. The whole treatment would be considerably improved if the authors would point out that the mobilities of the ions change with the ionic concentration, making it impossible to determine the degree of ionization of strong electrolytes from the simple λ/λ_0 ratio.

On page 239 the authors write "With the development of the theory of electrolytic dissociation, it was soon realized that the fundamental property of an acid is its ability to dissociate in aqueous solution to give a larger concentration of hydrogen ions than that which exists in pure water alone." A more general, more fundamental and more fruitful definition is that an acid is a substance which gives up a proton.

In justice to the authors it should be said that the same faults exist in most of the other introductory texts on theoretical chemistry. The reviewer recommends this book and would like to see it used as a basis for a second course in chemistry.

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Instrument Tests Tender Steaks. An instrument made from an ordinary automobile tire pressure-gauge for estimating the tenderness of meat, was described at the American Chemical Society meeting by Donald K. Tressler of Gloucester, Massachusetts, and William T. Murray. Another instrument for the same purpose is a modified form of a standard laboratory penetrometer.—*Science Service*

Vegetarians Live More Slowly. A study made on thirty long-time vegetarians shows that their basal metabolism is from ten to fifteen per cent below the average of habitual meat-eaters. Short-time vegetarianism does not seem to have such effects, said Prof. Glen Wakeham, of the University of Colorado, and Louis O. Hansom at the meeting of the American Chemical Society.—*Science Service*

Tougher Germs to Test Disinfectants. Standards for staphylococcus germs with which to test the strength of disinfectants have been too lax, said Dr. George F. Reddish, of St. Louis, Mo., at the meeting of the American Chemical Society. Weak germs will be excluded from the new standards incorporated in the forthcoming bulletin of the U. S. Food and Drug Administration on methods of testing disinfectants and antiseptics.—*Science Service*

Refrigerators Heat California Building. Refrigeration in sunny California now provides for winter heat. The same system that cools air in summer has been made to warm things up when the snow starts thickening on the mountain peaks.

In a new office building, erected for an electrical company in Los Angeles, suitable apparatus has been installed. As in an ordinary refrigeration system, the refrigerant is vaporized by absorbing heat from a container of water, which it cools. When it condenses it heats up the water of a second container.

Air is passed over the cooled water to make the building comfortable in summer. During the winter months, the water from the condenser is circulated through a tubular device which raises the building's air supply to a temperature of 80 degrees Fahrenheit. To provide for an outside source of energy, necessary in the operation of the system, the atmosphere is used. Towers on the roof of the building force an air draft which gives the water in the two containers temperatures from which the refrigeration system can operate.—*Science Service*